

**Confidential****GUIDELINES FOR PREPARATION OF FINAL REPORT -  
TECHNOLOGY GRANTS****Grant Number: ... TG/2012/Tech-D/02..... Date of Award: 22nd October 2012.....**

Project Title: Scaling up the invention of Spherical Container for Natural Rubber Latex Industry

Date the Project Work Commenced: 06<sup>th</sup> May 2013Date of completion of the grant period: 10<sup>th</sup> June 2014Date of submission of the final report: 10<sup>th</sup> September 2014.

Total allocation of funds by NSF: LKR 2,536,519.04.

Total expenditure of NSF funds at the time of completion of the grant period: LKR 2,274,466.62.

**Note to Grantee**

1. Final report should cover the work done during the total grant period.
2. Two bound copies are required and should be submitted within three months after completion of the grant period.
3. Final report should be prepared according to the following format and submitted through the Dean of the Faculty and Vice Chancellor/ Head of the institution (does not apply for individuals).
4. Specifications for attention when preparing the final report
  - to be printed an A4 paper
  - use single space and font size-`12.
  - pdf version in a CD to be submitted along with hard copies.
  - copies of published papers/ materials to be attached if relevant to the project and is a direct output of the project.
5. Final financial report should contain expenditure to-date and should be certified by the Bursar/ Accountant or self where the individual is not affiliated to any institution.

Final Reports should contain the following information. Report must be prepared according to the given format.

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| <b>A) Details of Team Members</b>  |
| <b>1. Team Member:</b> T.S.S.Gomes   |
| <b>2. Details of Collaborator:</b> Dr.W.M.G.Seneviratne,<br>Director, Rubber Research Institute<br>Thelawala Road, Rathmalana.   |
| <b>3. Places where the project was carried out:</b><br>Rubber Research Institute- Thelawala Road, Rathmalana, Department of Mechanical Engineering -University of Moratuwa, Richard Peiris and Company – Nawinna, RPC Polymers – Horana Poruwadanda Industrial Estate, Lalan Rubbers (Pvt) Limited- Algama Road, Horagasmankada.   |
| <b>4. Project personnel</b><br>i) <b>Number of personnel employed:</b> No paid personnel employed<br>ii) <b>Their status offer completion of the project:</b> -  |
| <b>5. Final financial statement is attached:</b> Yes   |
| <b>B) Executive summary of the project</b><br>Natural rubber latex production of the world is lead and dominated by Asia Pacific Countries such as Thailand, Indonesia, Malaysia, Vietnam, China, India, Philippine, Cambodia, and Sri Lanka where altogether they contributes around 94%. But it was observed that the existing natural rubber latex production technology which is now older than 100 years- has amalgamated several problems such as uncontrollable wastage of latex, chemicals, ammonia, water, energy and labor. Further it is combined with complications such as discharge of waste by polluting environment, effects in employee's health, atmosphere degradation by excessive ammonia evaporations and unsatisfied labor attitudes due to difficult working conditions they faced.<br><br>Therefore there is a global need to develop a new efficient and effective green technology for the natural rubber latex processing industries, which will minimize above material wastages, improve productivity and prevent adverse effects on the human and environment.<br><br>The project carried out under the grant of National Science Foundation on "Scaling up the invention of Spherical Container for Natural Rubber Latex Industry" is an invented spherical tank and a process that can help natural rubber latex industries in saving their valuable resources and effects in enhance the environmental performances.<br><br>The control tests of this project which carried out under the technical collaboration of Rubber Research Institute of Sri Lanka, by comparing conventional cylindrical tank and ecodesigned spherical tank revealed -the Percentage of latex saving on coagulated rubber as 42%, savings on Ammonia usage as 19.5% and savings on Labor usage as 59%. Therefore this project will enable the said natural rubber latex producing industries of Asia-Pacific countries to successfully address global change challenges through their scientific capacity development and will be a definite contribution for the sustainable development of future world natural rubber latex centrifuge industry linking to green production and consumption. |

**C) Report in detail- C1. Introduction/ Background****C1.1) Natural Rubber Latex Industry**

Sri Lanka is the 7th largest natural rubber latex producer in the world where latex processing and manufacturing industry plays a major role in global economy and makes a huge economic impact on rural poor livelihood. According to news bulletin of Association of Natural Rubber Producing Countries- Asia Pacific Countries leads and dominate natural rubber latex production in the world where the country wise existing average contributions are Thailand 35%, Indonesia 27%, Malaysia 9%, India 9%, Vietnam 8%, China 7%, Sri Lanka 1.5%, and Philippines 1 % respectively. In this industry natural rubber field latex which tapped from rubber trees in the plantation is processed in two forms named as liquid form and dry form- which will be selected in accordance with the final product manufactures requirement and passes through many collection transferring, transport, storing and handling processes.

**C1.2) Existing natural rubber latex centrifuge process**

Various capacities of Bulking Tanks in cylindrical or cubicle shapes are available in the Centrifuging Factories, which could be stored many thousands of wet kilograms of Field Latex. The field latex is bulked into these bulking tanks and added with D.A.H.P solution to remove the excess Magnesium which has an adverse effect on the end Product. After allowing the excessive Magnesium to settle for minimum 12 hours as Magnesium Hydrogen Phosphate which is known as Sludge, the bulked field latex then transferred to the main process named Centrifuging.

According to the available scientific studies natural rubber field latex is a suspension of minute particles of rubber in an aqueous serum. Here the rubber particles have a specific gravity around 0.91 and the serum has a specific gravity around 1.02. Therefore there is a natural tendency for the lighter rubber particles to gradually rise towards the surface of the latex. But the rubber particles are so small that they float extremely slowly upwards. Many factors, including convection, reduce the rate of separation even further. Under gravitational force, an average-sized rubber particle of 0.5 micron ( $\mu$ ) in diameter will take about 05 days to rise a distance of 01 cm. As the Separation under gravity is so slow that micro-biological activity will set in natural rubber latex long before useful separation occurs. The rate at which a particle rises of a given size will rise faster if the force applied is increased. This can be achieved by spinning the latex in a bowl and for this purpose latex industries use electrically driven centrifuging machines which rotate latex around 3500 rpm and produce concentrate fraction and a skim fraction separately.

Using the above methodology field latex which is having approximately 25% Dry Rubber Content (DRC) is subjected to an industrial manufacturing processes called centrifuging and divided in to two fractions where the more viscous or creamier fraction which contains around 60% of DRC will be the main product and is termed as centrifuged latex. The other is the byproduct named as skimmed latex which contains higher amount of serum/water with very low amount of latex. According to the final product manufactures requirement the said main product- centrifuged latex -having around 60% DRC is divided in to two types as follows.

- a) High ammonia latex -total alkalinity (as NH<sub>3</sub> %) around 0.6% - 0.72%
- b) Low ammonia latex - total alkalinity (as NH<sub>3</sub> %) around 0.2% - 0.27%

This centrifuged latex are stored in the storage tanks called maturation tanks and added occasionally with necessary preservatives, stabilizers and Ammonia Gas - according to required product type and allowed to keep for minimum 14 days in these tanks to ' ripen ' it – before issued to respective buyers for final product manufacturing.

The maturation tanks are available in various capacities in cylindrical or cubicle shapes. They are fitted with ammonia gas spreaders feeding from top of the tanks using rubber hoses or steel tubes, and slow-moving electrically driven motor paddles/stirrers for intermittent stirring of stored centrifuged latex during their maturation period.

To send the centrifuged- matured-natural rubber latex to respective buyers, transfer that in to bowser vehicles using long pipes / hoses, valves, and gravity or electricity or compressed air. Finally the empty maturation tank is subjected to evacuation of trapped ammonia fumes by blowing air using electrical fans and then manually cleaned to remove coagulated rubber deposited.

**C1.3) Technical Problem:** Presently I am working as a resource person on Cleaner Production Methodology (CP) for the National Cleaner Production Centre of Sri Lanka, set up for the Ministry of Industrial Development and Commerce. CP looks at input resources that how it flows through processes, and helps organization to reduce waste generation, environment pollution and improve efficiency of resource utilization.

During the Cleaner Production Assessments I carried out for Rubber Sector consultancy programmes, observed the following wastages and difficulties in-between collection of field latex at rubber plantation and centrifuge latex production processes such as

1. Uncontrollable wastage of rubber latex- chemicals- labor and ammonia gas,
2. Unsatisfied labor attitudes due to unhealthy working conditions they faced on high ammonia evaporation to surrounding,
3. Inconsistent quality of matured latex due to inefficient ammonia supply and stirrer arrangement,
4. Industries face serious problems with neighborhoods and government authorities due to high ammonia evaporation to environment,
5. Wastage of labor, water, energy and utensils during tank cleaning processes,
6. Poor quality of tank cleaning processes which increase VFA number due to difficulty of working inside a huge tank containing sludge and saturated with vaporized ammonia - are some of them.

Additionally I identified that “valve leaks, hose leaks, and use of rectangular and cylindrical shape tanks for latex storing has more influenced the above problems in existing processing methodology.

**C1.4) Photos of wastages and difficulties in existing processing methodology**





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TD/Tech-D/D3  
(As of December 21, 2010)



**C1.5) Ammonia gas usage in the existing methodology:**

The other problematic issue in this centrifuging industry is ammonia usage and it is a colorless gas with a characteristic pungent smell and also is corrosive. According to scientists- five environmental impacts due to Ammonia were observed- such as global warming (global scale impact), acidification and eutrophication (regional scale impact), human toxicity and photochemical oxidation (local scale impact). Further they have mentioned that Ammonia is effects in ecosystem changes. Thus, there is a special need to reduce the amount of ammonia fumes emitted during centrifuged latex production process. According to the existing technology the centrifuged latex storages in the maturation tanks are mixed with ammonia gas which is supplied from the top of the tank using rubber hoses. This system effects in high volume of ammonia (NH<sub>3</sub>) evaporation to environment without dissolving with latex resulting quality inconsistency of latex maturation batches.

**C1.6) Photos of Ammonia gas usage in the existing methodology**

Cylinders containing ammonia



Release of ammonia to tanks



Heat transfer unit with water



Ammonia gas supply lines to centrifuged latex maturation tanks

**C1.7) Technical Solution**

According to the United Nations Industrial Development Organization and United Nations Environmental Programme the Resource Efficient Cleaner Production (RECP) builds upon CP in accelerating the application of preventive environmental strategies to processes, products and services to increase efficiency and reduce risks to humans and the environment. RECP addresses the three economical, environmental and social sustainability dimensions - individually and synergistically as follows.

- a. Production Efficiency: optimization of the productive use of natural resources (materials, energy and water);
- b. Environmental management: minimization of impacts on environment and nature through reduction of wastes and emissions; and
- c. Human Development: minimization of risks to communities and support for their development.

**C1.7). The Invention**

Therefore it is a national and global need to develop a new technology, which can help to natural rubber latex production processes on minimization of their wastages, improve their productivity and prevent adverse effects in environment and human health. To overcome above shortcomings and to reduce the existing production cost - should think of new ways such as modifying equipment where necessary and improving processing techniques and controls. This led me in invention of new technology of Single Transfer- Multi Purpose- Spherical Container for rubber latex centrifuge industry,



The spherical container for latex handling is a new process and a product in that the volume to surface area of this spherical is average 19.5% lesser than existing cubicle shape tanks and further 13% lesser than existing cylindrical tank where this figure directly effected in reduction of skin rubber formation, and labor involvement. The circular shape of the spherical container itself provides a natural effective way by not having any corners to support the coagulation and stagnancy of latex. Its unique spherical shape well minimizes ammonia evaporation to environment and provides environment friendly working surrounding. The outer pipe assembly will provide an effective and efficient way to collect deposited sediment- from spherical tank. It help in easy way to separate sludge/sediments from spherical container units during centrifuging through height adjustable valve fixed to bottom, without making any disturbance to deposited sludge during bulking process. It will prevent 06 latex transfer stages such as- field latex transfer from pales to estate central tanks, from estate central tanks to bowser/tractor tanks, from bowser/tractor tank to factory bulking tanks, from factory maturation tank to buyers bowser/tractor tanks, from buyers bowser/tractor tanks to storage tanks and from storage tanks to production unit day tanks giving huge eco economic benefits. It will be easy for the workers to clean the empty spherical container units due to minimized skin rubber formation and circular shape having no any corners.

**C1.8) Milestones of the invention:**

- i. Holder of Sri Lanka Patent No: 15434 of Technology of ecodesigned spherical for latex handling -
- ii. Holder of World Intellectual Property Organization Application No: PCT/IB2010/052604 –under Patent Cooperation Treaty as the inventor of Container for latex handling,
- iii. Winner of best Industrial Applications of All Island Inventors Competition –Year 2009 -conducted by the Mechanical Engineering Division of University of Moratuwa, Katubadda.
- iv. Winner of Environmental Awards 2010 -Professional Category– Conducted by Sri Lanka Association for the Advancement of Science-Wijerama Mawatha, Colombo 07.
- v. Merit Award Winner of Presidential Awards 2010 - All Island Inventors Competition –conducted by the Sri Lanka Inventors competition.
- Vi. Selected as one of six inventions in the country to nominate for Ray Award Sri Lanka- year 2012.

**C2. Objectives:**

There were two objectives in this project as objective 1 and objective 2, as follows.

**C2.1) Objective 1.**

Design and fabrication of spherical tank of around 22500 liter capacity to be used as centrifuged latex maturation tank. (Capacity match to export one container load of centrifuge latex)



**C2.2) Objective 2.**

Design and fabrication of a mould for roto-moulding process, to mass produce transportable spherical tanks of around 1400 liter, to be used for rubber latex transportation in-between plantation and latex processing factory and similar applications.( capacity match to one cycle of centrifuging machinery involvement in centrifuge latex production)



**C3. Description of the work (against the proposed project design, work plan etc.)**

**C3.1- Objective 1 : Design and fabrication of spherical tank of around 22500 liter capacity to be used as centrifuged latex maturation tank. (Capacity match to export one container load)**

**C3.1.1 Description:**

**Optimization of the invention, Engineering designing and Tooling and fabrication of Mild Steel Spherical.**

The optimization of the invention for centrifuged latex maturation process was attended by Dr.Gamini Senevirathne,-Director of Rubber Research Institute of Sri Lanka, as the collaborator of this project. The Department of Mechanical Engineering of University of Moratuwa- helped me with their capabilities included with sophisticated computer designing laboratory and experience of Dr.Janaka Mangala and Lecturer Mr.Amal Senevirathne. It is only an unofficial help as the University of Moratuwa haven't accepted as a collaborator to this project. When the above drawings were completed and finalized for the mild steel spherical Tank of 04 mm thickness, mouth assembly, bottom outlet, stainless steel stirrer with gear box assembly, outlet valve and ammonia gas supply- the tooling and fabrication was initiated at the fabrication yard.



22500 liter Mild Steel Spherical Tank



Visit of NSF to the fabrication yard



Gear box assembly



Mouth assembly



Bottom outlet



Stainless steel stirrer

According to the given instruction by the project collaborator Dr.Gamini Senevirathne- Director of Rubber Research Institute of Sri Lanka the fabricated mild steel spherical tank and its accessories were finally transported and installed at the Centrifuging Factory of Lalan Rubbers (Pvt) Limited-at Algama Road, Horagasmankada-Sri Lanka, in order to evaluate performance of Spherical Latex Storage Tank against the Conventional Horizontal Cylindrical Latex Storage Tank.



Site selected at Lalan Rubbers



Foundation work started



Transported to centrifuging factory



Unloading at site



Positioned on the base foundation



S/Steel Stirrer fixed inside the tank



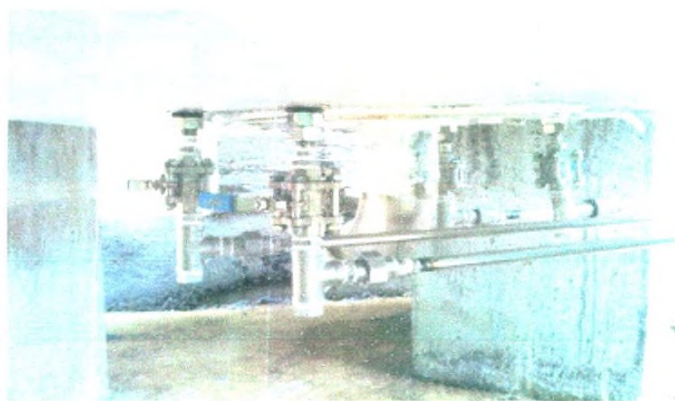
Fabricated the side manhole



Spherical and cylindrical maturation tanks

As previously said in the section of Technical Problem -C1.5) of Ammonia gas usage in the existing methodology, the existing rectangle or cylindrical maturation tanks are fitted with ammonia gas feeders which feeds from the top of the tanks using rubber hoses or steel tubes.

But this invented technology the gaseous ammonia is injected in to the maturation latex storages from the bottom of the tank- which is an upward injection methodology- by using a stainless steel pipes and nozzle assembly. This new system reduces ammonia usage, labor usage and enhances environmental conditions effectively and efficiently.



Stainless steel nozzle assembly



S/Steel nozzle assembly with outlet pipe



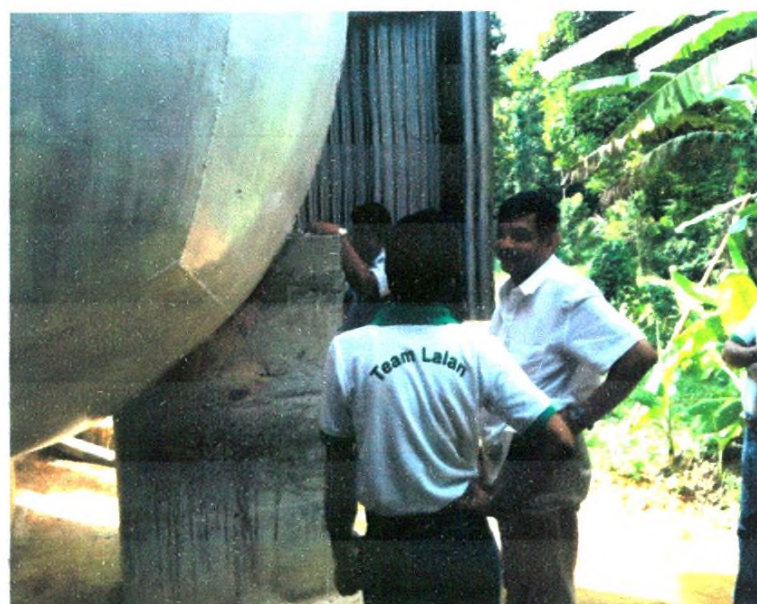
S/Steel heat transfer unit for Ammonia Gas



S/Steel nozzle connecting unit



Director of Rubber Research Institute -Dr.Gamini Senevirathene –inspected the site



**Final Specification of the 22500 liter Mild Steel Spherical Tank and its accessories were as follows.**

1. Thickness of the mild steel plates = 04mm
2. Diameter of the spherical tank = 338.328 cm
3. Height of the mouth = 700mm
4. Diameter of the mouth = 750mm
5. Full volume capacity = 21300 liters
6. The accuracy of the fabricated mild steel spherical versus original design = about 95%.
7. The diameter of the stainless steel shaft of the stirrer = 50mm
8. Number of stirrer blades included in the shaft = 04
10. The speed of the stirrer blades = 18 Rpm
11. The diameter of the stainless steel outlet valve = 75mm
12. The number of stainless steel ball valve fixed to the outlet = 01
13. The pressure of the ammonia gas supply = 6.0 to 6.5 bar
14. The Diameter of the stainless steel ammonia gas supply line = 12mm
15. The number of ammonia gas injecting nozzles provided into the system = 04
16. Capacity of the heat transfer water bath = 210 liters
17. Rate of supply of ammonia gas per hour = between 10Kg to 25Kg

When completed the optimization of the invention, engineering designing and tooling and fabrication of mild steel spherical as above according to the Work Plan and Gantt chart, then processing trials were initiated according to the instructions given by Dr.Gamini Senevirathene- Director of Rubber Research Institute.

**C.3.1.2 Processing trials and Method of Comparison:**

Comparison is made on the following performance criteria, between the spherical latex storage tank and the conventional cylindrical horizontal tank.

3.1.2. 1. A horizontally placed cylindrical tank with the same/closest capacity is taken for storage of latex for comparison of performance.

3.1.2 .2. Field latex is processed in to centrifuged latex and divided the production in to two portions and the tanks were filled simultaneously.

3.1.2.3. Latex is filled in to the two tanks with closest equal quantities.

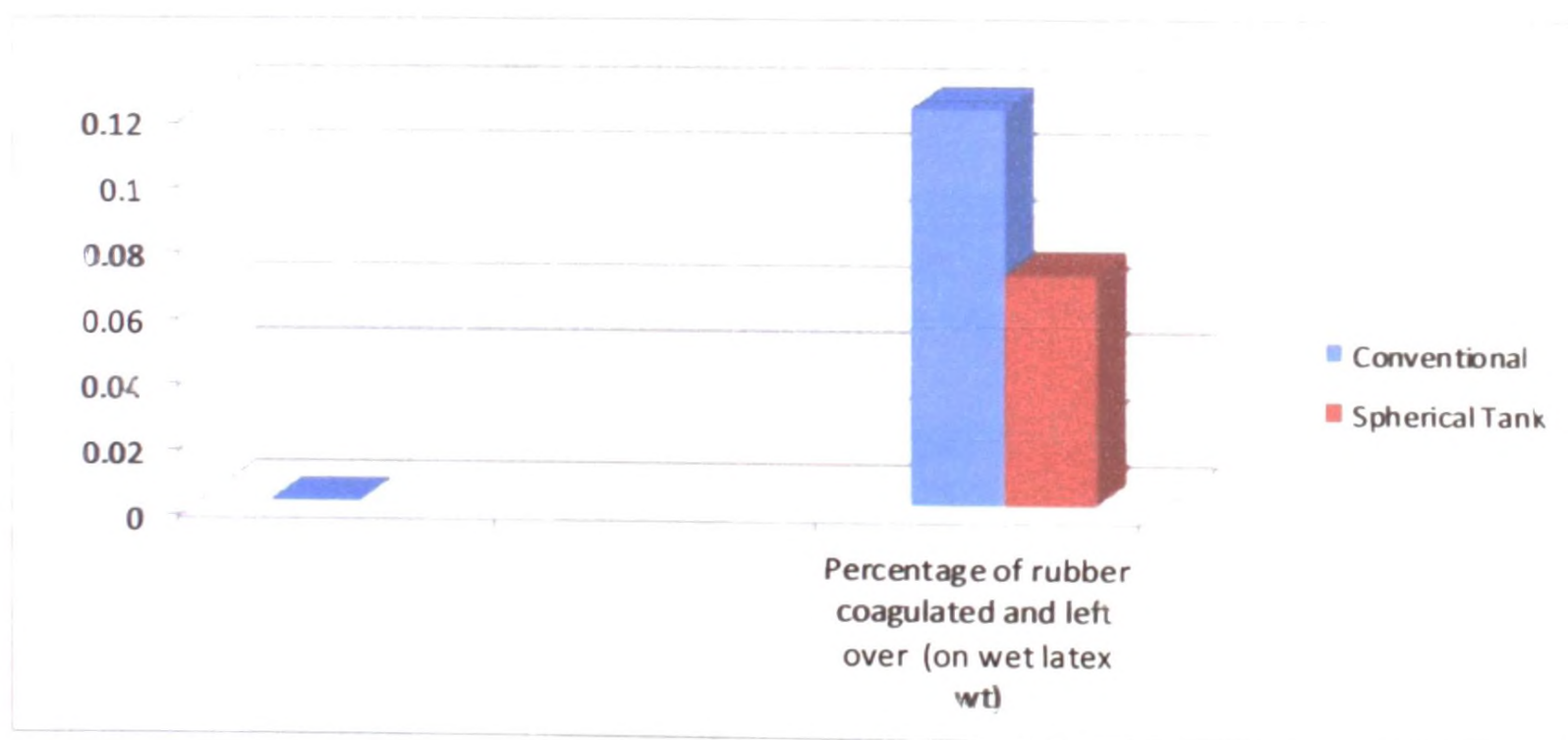
3.1.2.4. Latex is matured to the same extent in the two tanks.

3.1.2.5. Following criteria are used to assess the performance of latex maturation batches.

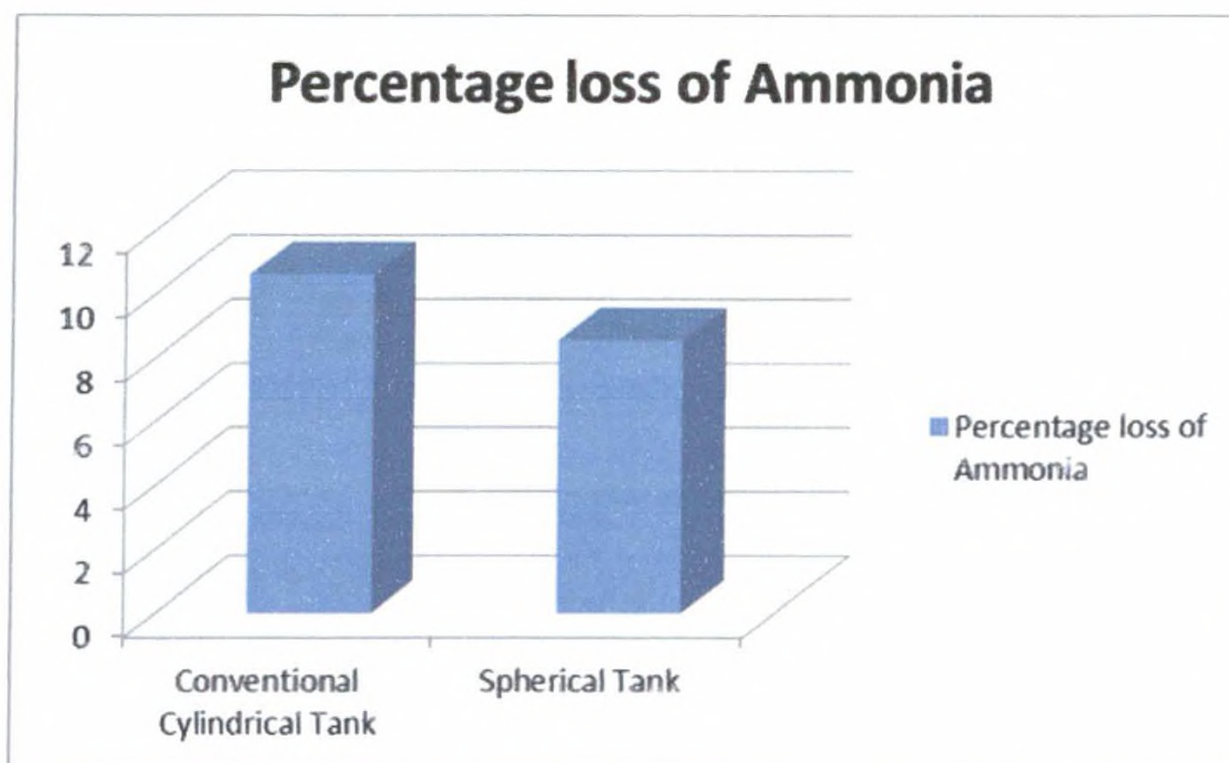
- a. Percentage of accumulated coagulated rubber inside the tank after the matured latex is removed, percentage of ammonia incorporation during the entire maturation period and percentage of labor involvement in tank cleaning process,
- b. Quality variation - alkalinity (as ammonia), MST, VFA No and KOH number,( tested once in 5 days)
- c. Temperature of latex at the surface of the tanks, (This is measured in the afternoon daily but not a performance criterion. Monitored to ascertain if there is any temperature difference which might affect the properties of latex.

**C.3.1.3 The Results**

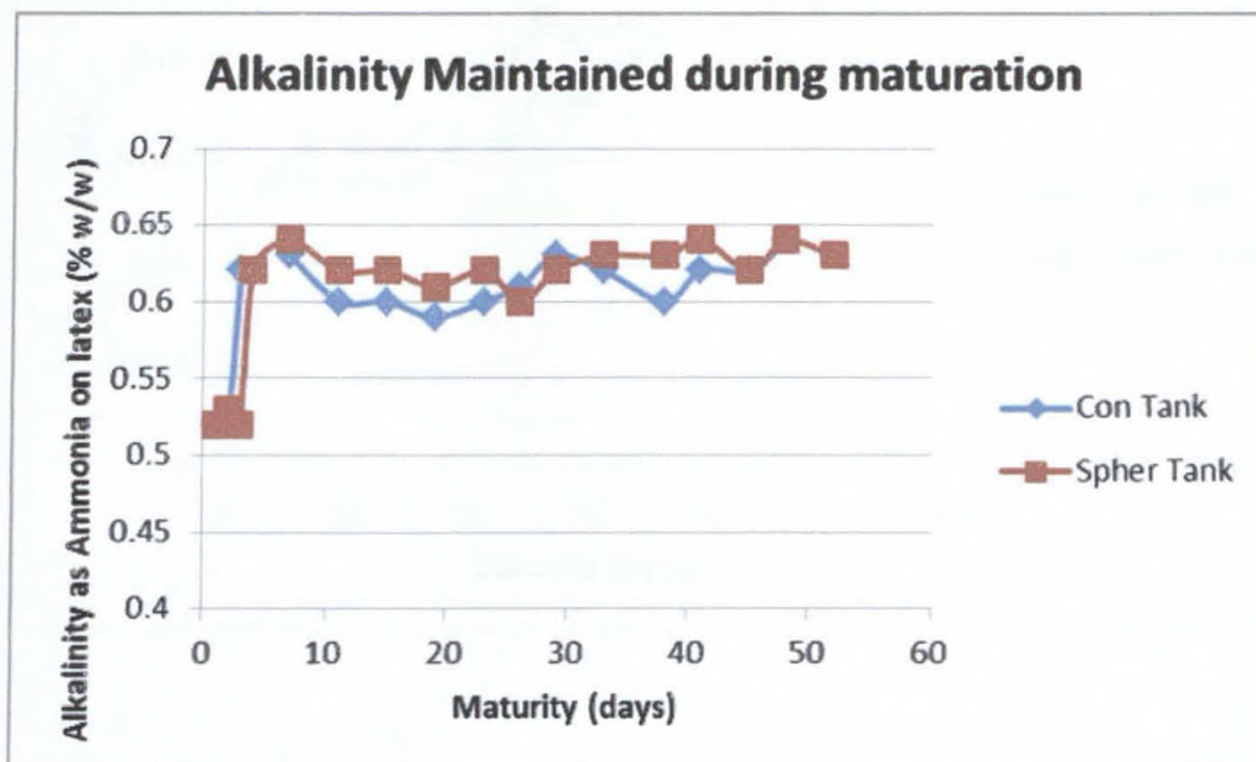
| <b>C.3.1.3. 1. Comparison of coagulated and left over rubber wastage</b> |  |  |
|--|--|--|
| <b>Description</b>   | <b>Conventional<br/>Cylindrical Tank</b> | <b>Spherical Tank</b>                    |
| Full Capacity (liters)   | 23783                                    | 20553.5                                  |
| Centrifuged latex filled day 1 (2013. 12 .30)                            | 5121                                     | 6912                                     |
| Centrifuged latex filled day 2 (2013. 12 .31)                            | 9661                                     | 5643                                     |
| Centrifuged latex filled day 3 (2014. 01 .01)                            | 4658                                     | 5085                                     |
| Centrifuged latex filled day 4 (2014. 01 .02)                            | 2333                                     | 1685                                     |
| Filled total latex qty Wet kg  | 21773                                    | 19325                                    |
| Centrifuged latex filled final volume (L)                                | $(21773 \times 0.95) = 22919$            | $(19325 \times 0.95) = 20342$            |
| Coagulated rubber removed (dry) kg                                       | 27.84                                    | 14.5                                     |
| Percentage of coagulated rubber removed<br>(on wet latex wt)             | 0.12                                     | 0.07                                     |
| <b>Percentage of latex saving on coagulated<br/>rubber</b>               |  | $(0.12 - 0.07) \times 100 / 0.12 = 42\%$ |



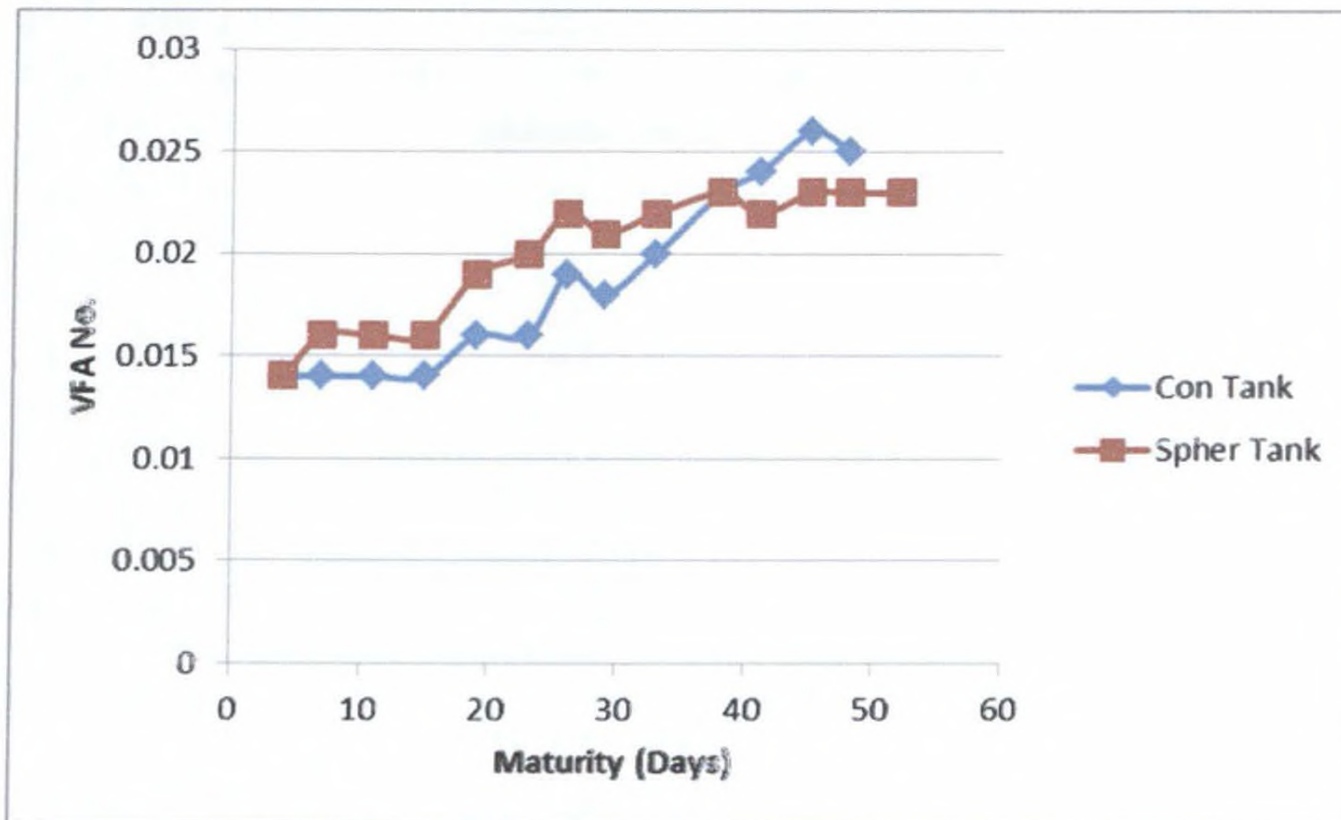
| <b>C.3.1.3.2. Comparison of incorporation of ammonia gas during maturation period</b> |                                      |                       |
|---|--------------------------------------|-----------------------|
| <b>Date</b>   | <b>Conventional Cylindrical Tank</b> | <b>Spherical Tank</b> |
| 30.12.13  | 70                                   | 50                    |
| 31.12.13  | 37                                   | 0                     |
| 01.01.14  | 0                                    | 50                    |
| 02.01.14  | 9                                    | 0                     |
| 03.01.14  | 0                                    | 4                     |
| 06.01.14  | 0                                    | 2                     |
| 10.01.14  | 4                                    | 0                     |
| 18.01.14  | 6.5                                  | 0                     |
| 27.01.14  | 0                                    | 8                     |
| 06.02.14  | 5                                    | 0                     |
| <b>Total Qty of ammonia incorporated (kg)</b>   | <b>131.5</b>                         | <b>114</b>            |
| <b>Total qty of ammonia retained (kg)</b>   | <b>117.6</b>                         | <b>104.3</b>          |
| <b>Qty of total loss of ammonia (kg)</b>  | <b>13.9</b>                          | <b>9.7</b>            |
| <b>Percentage of loss of Ammonia</b>  | <b>10.570</b>                        | <b>8.509</b>          |
| <b>Percentage of ammonia saving on loss of ammonia</b>                                | $(10.570-8.509)*100/10.570= 19.5\%$  |                       |



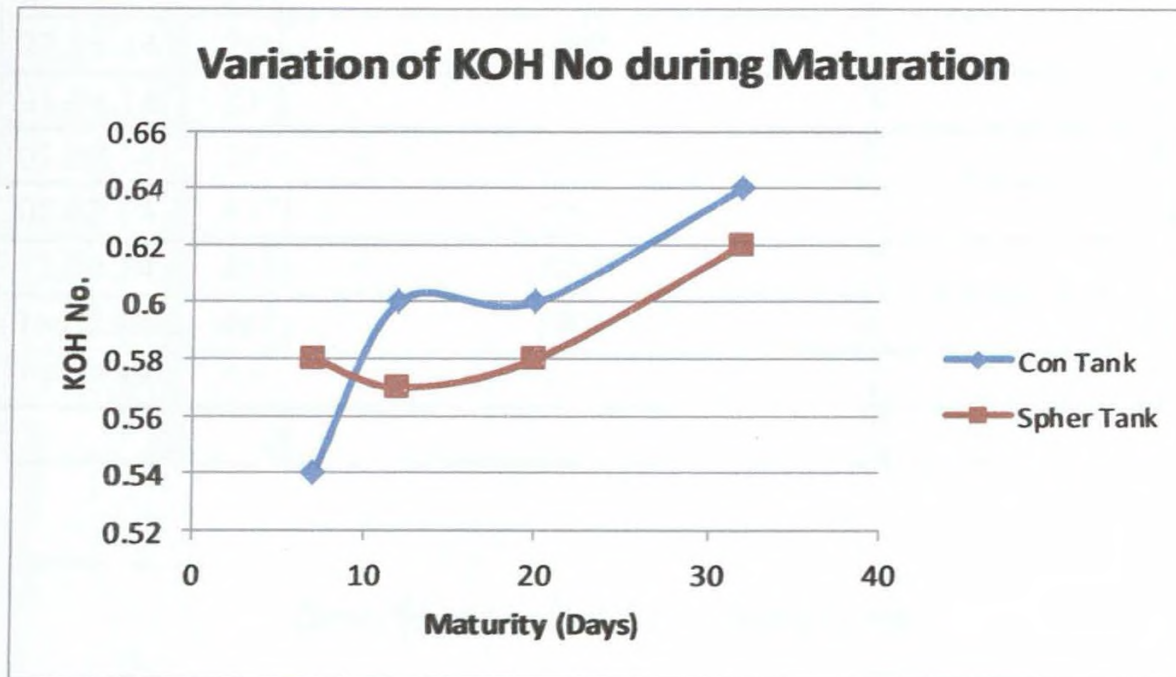
| C.3.1.3.3. Analysis of Alkalinity variation during maturation period |     |                   |                |
|--|-----|-------------------|----------------|
| Date   | Day | Conventional Tank | Spherical Tank |
| 30.12.13   | 1   | 0.52              | 0.52           |
| 31.12.13   | 2   | 0.52              | 0.53           |
| 01.01.14   | 3   | 0.62              | 0.52           |
| 02.01.14   | 4   |                   | 0.62           |
| 05.01.14   | 7   | 0.63              | 0.64           |
| 09.01.14   | 11  | 0.60              | 0.62           |
| 13.01.14   | 15  | 0.60              | 0.62           |
| 17.01.14   | 19  | 0.59              | 0.61           |
| 21.01.14   | 23  | 0.60              | 0.62           |
| 24.01.14   | 26  | 0.61              | 0.60           |
| 27.01.14   | 29  | 0.63              | 0.62           |
| 31.01.14   | 33  | 0.62              | 0.63           |
| 05.02.14   | 38  | 0.60              | 0.63           |
| 08.02.14   | 41  | 0.62              | 0.64           |
| 12.02.14   | 45  | 0.62              | 0.62           |
| 15.02.14   | 48  | 0.64              | 0.64           |
| 19.02.14   | 52  |                   | 0.63           |



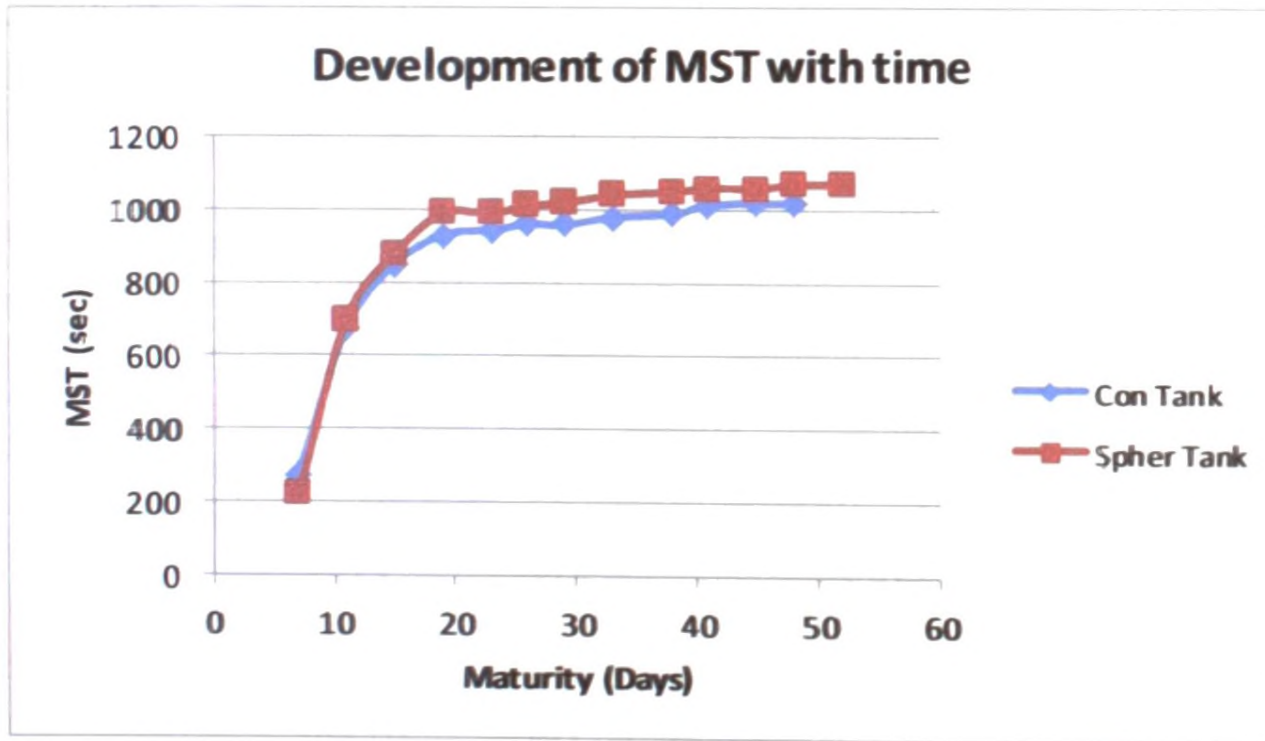
| C.3.1.3.4 Analysis of VFA No variation during maturation period |     |                   |                |
|---|-----|-------------------|----------------|
| Date  | Day | Conventional Tank | Spherical Tank |
| 02.01.14  | 4   | 0.014             | 0.014          |
| 05.01.14  | 7   | 0.014             | 0.016          |
| 09.01.14  | 11  | 0.014             | 0.016          |
| 13.01.14  | 15  | 0.014             | 0.016          |
| 17.01.14  | 19  | 0.016             | 0.019          |
| 21.01.14  | 23  | 0.016             | 0.020          |
| 24.01.14  | 26  | 0.019             | 0.022          |
| 27.01.14  | 29  | 0.018             | 0.021          |
| 31.01.14  | 33  | 0.020             | 0.022          |
| 05.02.14  | 38  | 0.023             | 0.023          |
| 08.02.14  | 41  | 0.024             | 0.022          |
| 12.02.14  | 45  | 0.026             | 0.023          |
| 15.02.14  | 48  | 0.025             | 0.023          |
| 19.02.14  | 52  |                   | 0.023          |



| C.3.1.3.5 Analysis of KOH No variation during maturation period |     |                   |                |
|---|-----|-------------------|----------------|
| Date  | Day | Conventional Tank | Spherical Tank |
| 05.01.14  | 7   | 0.54              | 0.58           |
| 10.01.14  | 12  | 0.60              | 0.57           |
| 18.01.14  | 20  | 0.60              | 0.58           |
| 19.02.14  | 52  | 0.64              | 0.62           |



| C.3.1.3.6 Analysis of Mechanical Stability Time variation during maturation period |     |                   |                |
|--|-----|-------------------|----------------|
| Date   | Day | Conventional Tank | Spherical Tank |
| 05.01.14   | 7   | 275               | 225            |
| 09.01.14   | 11  | 675               | 700            |
| 13.01.14   | 15  | 850               | 880            |
| 17.01.14   | 19  | 930               | 990            |
| 21.01.14   | 23  | 945               | 990            |
| 24.01.14   | 26  | 960               | 1010           |
| 27.01.14   | 29  | 960               | 1020           |
| 31.01.14   | 33  | 980               | 1040           |
| 05.02.14   | 38  | 990               | 1050           |
| 08.02.14   | 41  | 1015              | 1060           |
| 12.02.14   | 45  | 1020              | 1060           |
| 15.02.14   | 48  | 1020              | 1070           |
| 19.02.14   | 52  |                   | 1070           |
|  |     |                   |                |



| <b>C.3.1.3.7. Temperature Measurement (in centigrade) during maturation period</b> |         |                  |                |
|--|---------|------------------|----------------|
| Date   | Time    | Cylindrical Tank | Spherical Tank |
| 30.12.13   | 4.30 pm | 33.0             | 33.0           |
| 31.12.13   | 4.00 pm | 30.0             | 30.0           |
| 01.01.14   | 4.30 pm | 31.0             | 31.5           |
| 02.01.14   | 4.15 pm | 30.0             | 30.5           |
| 03.01.14   | 5.00 pm | 29.5             | 30.5           |
| 04.01.14   | 4.35 pm | 29.0             | 30.0           |
| 05.01.14   | 4.45 pm | 28.5             | 29.0           |
| 06.01.14   | 4.15 pm | 28.5             | 29.0           |
| 07.01.14   | 4.30 pm | 29.0             | 29.0           |
| 08.01.14   | 4.45 pm | 29.0             | 29.0           |
| 09.01.14   | 5.00 pm | 29.0             | 29.5           |
| 10.01.14   | 4.00 pm | 29.5             | 30.0           |
| 11.01.14   | 5.10 pm | 29.0             | 30.0           |
| 12.01.14   | 4.25 pm | 29.0             | 30.0           |
| 13.01.14   | 5.15 pm | 29.5             | 30.5           |
| 14.01.14   | 4.40 pm | 30.0             | 30.0           |
| 15.01.14   | 5.00 pm | 29.0             | 29.0           |
| 16.01.14   | 4.30 pm | 30.0             | 30.0           |
| 17.01.14   | 5.00 pm | 30.5             | 30.5           |
| 18.01.14   | 4.45 pm | 30.0             | 30.0           |
| 19.01.14   | 4.20 pm | 30.0             | 30.5           |
| 20.01.14   | 4.30 pm | 30.0             | 30.5           |
| 21.01.14   | 5.00 pm | 30.5             | 30.5           |
| 22.01.14   | 4.15 pm | 30.5             | 31.0           |
| 23.01.14   | 4.20 pm | 30.0             | 30.5           |
| 24.01.14   | 4.30 pm | 30.5             | 31.0           |
| 25.01.14   | 4.00 pm | 30.5             | 30.5           |
| 26.01.14   | 4.15 pm | 30.0             | 30.0           |
| 27.01.14   | 4.25 pm | 30.0             | 30.0           |
| 28.01.14   | 4.00 pm | 30.5             | 30.5           |
| 29.01.14   | 4.35 pm | 30.0             | 30.0           |
| 30.01.14   | 4.45 pm | 29.5             | 29.5           |
| 31.01.14   | 5.00 pm | 29.5             | 29.5           |
| 01.02.14   | 4.30 pm | 30.0             | 30.5           |
| 02.02.14   | 5.00 pm | 30.5             | 30.5           |
| 03.02.14   | 4.30 pm | 30.0             | 30.0           |
| 05.02.14   | 4.45 pm | 30.0             | 30.0           |
| 06.02.14   | 4.20 pm | 29.5             | 30.0           |
| 07.02.14   | 4.00 pm | 29.0             | 30.0           |
| Continued and results were same  |         |                  |                |

| <b>C.3.1.3.8. Stirring Time during maturation period</b> |                                      |                              |                 |                             |                              |                 |  |
|--|--------------------------------------|------------------------------|-----------------|-----------------------------|------------------------------|-----------------|--|
|  | <b>Conventional Cylindrical Tank</b> |                              |                 | <b>Spherical Tank</b>       |                              |                 |  |
| <b>Date</b>  | <b>Stirrer on at ( am )</b>          | <b>Stirrer off at ( am )</b> | <b>Duration</b> | <b>Stirrer on at ( am )</b> | <b>Stirrer off at ( am )</b> | <b>Duration</b> |  |
| 01.01.14   | 10.00                                | 10.10                        | 10              | 10.35                       | 10.45                        | 10              |  |
| 02.01.14   | 10.25                                | 10.35                        | 10              | 11.15                       | 11.25                        | 10              |  |
| 03.01.14   | 10.10                                | 10.20                        | 10              | 11.05                       | 11.15                        | 10              |  |
| 04.01.14   | 10.10                                | 10.20                        | 10              | 10.50                       | 11.00                        | 10              |  |
| 05.01.14   | 10.00                                | 10.10                        | 10              | 10.50                       | 11.00                        | 10              |  |
| 06.01.14   | 10.35                                | 10.45                        | 10              | 11.05                       | 11.15                        | 10              |  |
| 07.01.14   | 9.50                                 | 10.00                        | 10              | 10.50                       | 11.00                        | 10              |  |
| 08.01.14   | 10.20                                | 10.30                        | 10              | 11.25                       | 11.35                        | 10              |  |
| 09.01.14   | 9.55                                 | 10.05                        | 10              | 10.30                       | 10.40                        | 10              |  |
| 10.01.14   | 10.35                                | 10.45                        | 10              | 11.10                       | 11.20                        | 10              |  |
| 11.01.14   | 10.10                                | 10.20                        | 10              | 10.55                       | 11.05                        | 10              |  |
| 12.01.14   | 10.05                                | 10.15                        | 10              | 11.00                       | 11.10                        | 10              |  |
| 13.01.14   | 10.00                                | 10.10                        | 10              | 10.50                       | 11.00                        | 10              |  |
| 14.01.14   | 10.05                                | 10.15                        | 10              | 10.30                       | 10.40                        | 10              |  |
| 15.01.14   | 10.10                                | 10.20                        | 10              | 11.00                       | 11.10                        | 10              |  |
| 16.01.14   | 9.55                                 | 10.05                        | 10              | 10.45                       | 10.55                        | 10              |  |
| 17.01.14   | 10.30                                | 10.4                         | 10              | 11.05                       | 11.15                        | 10              |  |
| 18.01.14   | 10.10                                | 10.2                         | 10              | 10.50                       | 11.00                        | 10              |  |
| 19.01.14   | 10.10                                | 10.2                         | 10              | 10.50                       | 11.00                        | 10              |  |
| 20.01.14   | 10.05                                | 10.15                        | 10              | 11.05                       | 11.15                        | 10              |  |
| 21.01.14   | 10.40                                | 10.5                         | 10              | 11.15                       | 11.25                        | 10              |  |
| 22.01.14   | 10.10                                | 10.2                         | 10              | 10.45                       | 10.55                        | 10              |  |
| 23.01.14   | 9.10                                 | 9.2                          | 10              | 9.50                        | 10.00                        | 10              |  |
| 24.01.14   | 9.35                                 | 9.45                         | 10              | 10.25                       | 10.35                        | 10              |  |
| Continued and results were same                          |                                      |                              |                 |                             |                              |                 |  |

| C.3.1.3.9. Collected data at Lalan Rubbers- Warakapola on comparison of tank cleaning processes of Spherical Tank vs. Conventional Cylindrical Tank |  |  |  |
|---|--|--|--|
|   | Description  | Conventional Cylindrical Tank  | New Spherical Tank   |
| 1   | Latex Maturated- in Wet Kg   | 20250  | 19325  |
| 2   | Time kept the tank for drying the latex deposited on inside walls -before employing labors for cleaning.   | 15 hrs= 900 minutes,   | 2 hrs=120minutes   |
| 3   | Labor minutes spent for removal of side Manhole  | No side manhole.   | 22 minutes   |
| 4   | Labor minutes spent to collect remaining latex with coagulants at the bottom of tank                       | 144 minutes  | 07 minutes   |
| 4a  | Removed as maturated latex in Kilograms(which collected and transferred to next tank ready for maturation) | 82.5 kg  | 8.5 wet Kg   |
|   |  | $(82.5/20250) \times 100 = 0.407\%$  | $(8.5/19325) \times 100 = 0.044\%$   |
|   |  | Saving in spherical container= $0.407 - 0.044 = 0.363\text{kg per } 100\text{Kg}$  |  |
| 5   | Time kept the tank to dry the left coagulants at the bottom, before employing labors for tank cleaning.    | 20 hrs.=1200 min,  | 113min   |
| 6   | Labor minutes spent to remove remaining coagulants from the tank   | included in Item 4.  | 30 minutes   |
| 7   | Labor minutes spent to remove Dried Skin Rubber from inside tank walls.                                    | 535 minutes  | 205 minutes  |
| 7a  | Removed as Dried Rubber in Kilograms (Dry Kg)  | 27.84  | 14.5   |
| 8   | Total labor minutes spent  | 679 minutes  | 264 minutes  |
| 9   | Labor minutes spent per wet Kg   | $(679/20250) = 0.034$  | $(264/19325) \times 100 = 0.014$   |
| 10  | Percentage of saving of labor on spherical tank cleaning process   | $-(0.034-0.014)/0.034 \times 100 = 59\%$   |  |
| 11  | Remarks in the tank cleaning process( Resources utilized, special equipment used, labor attitudes- etc)    | <p>1. Tank to be kept for a day for drying the leftovers before employed workers to attend cleaning process.</p> <p>2. Tea time, lunch time and also the rest time in-between the work -were excluded from the calculation.</p> <p>3. Equipment utilized: Ladder, plastic can, rope, hook, bucket, Barrel, Plastic square chest and Flat form scale.</p> <p>4. The maturated latex which collected and transferred to next maturation tank for rework is a total loss to the company. Because this has absorbed total materials, chemicals, energy, ammonia, labor and space which all are money of the company. Therefore it should be minimized as much as possible.</p> | <p>1. Same day employed the workers to attend cleaning process as the leftovers had been dried within 02 hours.</p> <p>2. Only one person attended the total tank cleaning process.</p> <p>3. Equipment utilized: Plastic can, two buckets, Iron plank, and Electronic scale.</p> <p>4. The maturated latex transferred to next maturation tank for rework is minimized.</p> |

**C3.2. Description of the work (against the proposed project design, work plan etc.)****On Objective 2:**

Design and fabrication of a mould for roto-moulding process, to mass produce transportable spherical tanks of around 1400 liter, to be used for rubber latex transportation in-between plantation and latex processing factory and similar applications. (Capacity match to one cycle of centrifuging machinery involvement in centrifuge latex production)

**C3.2.1. Description:****C3.2.1.1. Optimization of the invention, Material Development, Engineering designing and fabrication of the Rotomold:**

The optimization of the invention for natural rubber field latex collection and factory bulking process was attended by Dr.Gamini Senevirathne,-Director of Rubber Research Institute of Sri Lanka, as the collaborator of this project. The Department of Mechanical Engineering of University of Moratuwa-consist with Dr.Janaka Mangala and Lecturer Mr.Amal Senevirathne unofficially helped me again on mold designing. When the drawings were finalized the tooling and fabrication was initiated at the fabrication yard.

The production of Rotomould was started by making a suitable Hydraulic Press Machine, a Female Die and a Male Die. Then hydraulically pressed several hemispheres using said Female Die and Male Die by 02 mm thick Mild Steel Sheets. But observed deformations and formation of wrinkles on all the pressed hemispheres where we were not able to rectify these defects anyhow.

Therefore informed the above problem to technologist of RPC Polymers (Industrial Partner) and request their permission to increase the thickness of the rotomould up to 04mm, in order to overcome the deformations and wrinkles. But they were not agreed to increase the thickness of the mould, as uneven heat transfer problems may arises in the LLDPE TANKS during their factory production process.

So started to make the Rotomould by Foundry Method and it was also failed due to formation of unlimited blowholes on the hemispheres. (First to make a Waththu Mala and then form a Mold-Method)

Finally by sheet metal fabrication methodology, the fabrication of rotomould completed successfully.



Transport of finished rotomold



Unloading at RPC Polymers

To go ahead with the pilot production of rotomolded spherical tanks, the completed rotomold then handed over to RPC Polymers at Horana-poruwadanda Industrial Estate, which comes under the Richard Peiris and Company of Sri Lanka and produced sample spherical tanks through their rotomolding process, by using Linear Low Density Poly Ethylene (LLDPE) as the base raw material.



Produced LLDPE Spherical tanks



LLDPE Spherical tanks at Lalan Rubbers



Mouth of the LLDPE Spherical tank



Lid of the LLDPE Spherical tank

**Final Specification of the 1400 liter capacity - Mild Steel -Spherical Rotomold and its accessories were as follows.**

1. Thickness of the mild steel plates used = 02mm
2. Diameter of the spherical mould = 1450mm
3. Method to use for rotomolding = carrier of Bi axial mounting
4. No of dowel pins used = 04
5. No of clamps used = 19
6. Diameter of the spherical base= 615mm
7. Height of the mouth of the molded spherical tank = 91 mm
8. Diameter of the mouth of the molded spherical tank = 416mm
9. Height of threaded area of the mouth= 50mm
10. Thickness of the molded lid of the spherical tank = 20mm
11. Full volume capacity of the molded spherical tank = 1450 liters
12. The accuracy of the fabricated mild steel spherical versus original design = about 97%.
13. The diameter of the outlet valve of the molded spherical tank = 50mm
14. The latex flow rate from spherical tank to centrifuge machines = 550 to 600 liters per hour

**C3.2.1.2. Processing trials and Method of Comparison of objective 2:**

When completed the production of Linear Low Density Poly Ethylene spherical tanks as above, the processing trials were initiated according to the instructions given by Dr. Gamini Senevirathene-Director of Rubber Research Institute, in the aim of Evaluation of Performance of Spherical Tank in the Field Latex Bulking Process against Conventional Rectangular Tank and a Cylindrical Tank which is having a bottom of conical shape.



Rectangular bulking tank



Conical bottom bulking tank



Spherical bulking Tank

**C3.2.1.3. Comparison of the field latex bulking process is to be made on the following criteria:**

- a. Effectiveness in separation of field latex from deposited sludge through the height adjustable valve fixed at the bottom of spherical tank.
- b. Savings due to transfer of all field latex in to centrifuging process through height adjustable valve, fixed at the bottom of spherical tank,
- c. Effectiveness in removing deposited sludge in the spherical tank after bulking process,
- d. Effectiveness in analyzation of collected sludge scientifically- according to type of rubber clones, weather conditions, area planted, soil conditions and weather patterns etc.
- e. Analyzation of collected sludge after bulking process (especially Magnesium Hydrogen Phosphate) – in the aim of converting them to useful by products.
- f. Cost reduction in Effluent Treatment Plant- due to less waste load transfers in to the treatment process through spherical tank cleaning process.
- g. Cost reduction due to reduced labor usage, compressed air usage and utensils usage through spherical tank cleaning process.

**C3.2.1.4. Method of Comparison of objective 2:**

- a. A conventional rectangular bulking tank and another cylindrical tank having a conical shape bottom are taken for the bulking of field latex for comparison of above performance with spherical tank.
- b. No any bulking tank is available in the factory with the same/closest capacity to the spherical tank. Therefore the capacities of both selected tanks for comparison of above said performances were higher than the volume of the spherical tank.

- c. The tanks are filled separately with field latex delivered to the factory by different bowsers.
- d. Field latex stored in the three tanks were added with same chemicals calculated according to their quantity of latex in each tank.
- e. Finally all field latex in the three tanks was bulked to the same extent for more than 18 hours and connected them to centrifuging process individually.
- f. After individually subjected to factory centrifuging process of each above said bulking tanks, the cleaning processes were started and outcomes were recorded consequently.

**C3.2.1.5. Criteria used to assess the performance of objective 2:.**

According to the above data collections carried out at the centrifuging plant, the following criteria were used to assess the performances of the field latex bulking process of the spherical tank.

- a. Percentage of bulked field latex directly feed in to the centrifuging process,
- b. Percentage of balance field latex transfered in to next bulking tank for centrifuging
- c. Percentage of labor usage for tank and other equipment cleaning after bulking process.
- c. Percentage of coagulated rubber accumulation inside the tank after bulked latex transferrin.
- d. Percentage of water usage for tank cleaning process.
- e. Effectiveness of sludge removal and sludge handling in the factory production process.
- f. Percentage of field latex transfers for degraded crepe rubber production.
- h. Percentage of concentrated sulfuric acid used for degraded crepe rubber production.
- i. Percentage of reduced work load of effluent treatment plant and enhancement of environment.

**C3.2.1.5.1. Photos of some notable features in the existing bulking process on objective 2:**



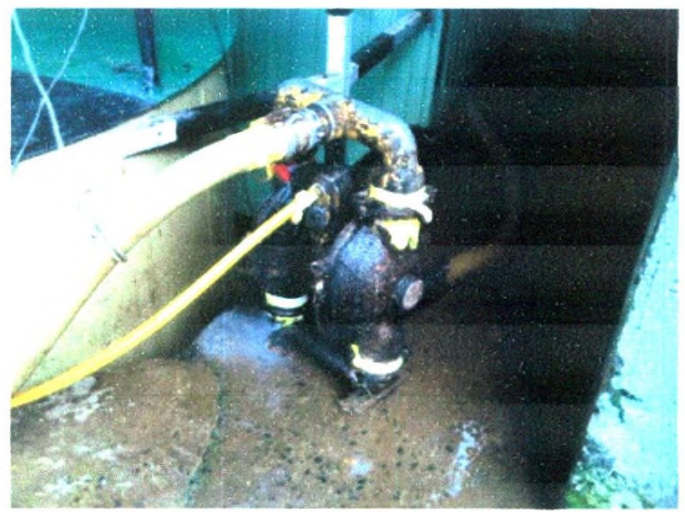
Centrifuges and square bulking tanks



Outlet valve above the bottom of tank



Pumping balance latex to next tank



Vacuum Pump using compressed air



Long hoses used for latex transferring



Cleaning of clogged valve



Hose leaks



Dismantled vacuum pump due to clogging



Washout of the rectangular tank



Cleaning of bottom of conical shape tank



Wash out flows through drains to degrade crepe rubber production



Cleaning inside a hose

| <b>C3.2.1.5.2. Collected Data of Bulking Tank Cleaning on objective 2:</b> |   |                         |                       |                         |
|--|---|-------------------------|-----------------------|-------------------------|
|  | <b>Description</b>  | <b>Spherical Tank</b>   | <b>Rectangle Tank</b> | <b>Cylindrical Tank</b> |
| <b>1</b>   | <b>Field Latex filled-wet Kg</b>  | <b>1630</b>             | <b>4116</b>           | <b>5685</b>             |
| <b>1a</b>  | <b>Pumped out balance field latex to next tank-wet Kg</b>   | <b>0</b>                | <b>422.15</b>         | <b>323.00</b>           |
| <b>1b</b>  | <b>Field Latex sent for centrifuging-wet Kg (Yield)</b>   | <b>1630.00</b>          | <b>3693.85</b>        | <b>5362.00</b>          |
| <b>1c</b>  | <b>% of Field Latex sent for centrifuging- (Yield)</b>  | <b>100</b>              | <b>90</b>             | <b>94</b>               |
| <b>2a</b>  | <b>Labour to pump out balance field latex to next tank -in minutes</b>  | <b>0</b>                | <b>38.0</b>           | <b>62.0</b>             |
| <b>2b</b>  | <b>Resources ( compressed air, hoses etc) used to pump out balance field latex to next tank ( V = Any Specified Value )</b> | <b>0</b>                | <b>38 x V</b>         | <b>62 x V</b>           |
| <b>3</b>   | <b>Removed Latex + Sludge from the bottom valve - in Kg</b>   | <b>3.850</b>            | <b>105.54</b>         | <b>49.780</b>           |
| <b>3a</b>  | <b>% of Removed Latex + Sludge from the bottom valve</b>  | <b>0.2</b>              | <b>2.6</b>            | <b>0.9</b>              |
| <b>3b</b>  | <b>Labour used to remove Latex + Sludge from bottom valve- minutes</b>  | <b>1.0</b>              | <b>4.0</b>            | <b>2.0</b>              |
| <b>4</b>   | <b>Water used to remove remaining sludge -in liters</b>   | <b>0.0</b>              | <b>316.20</b>         | <b>74.40</b>            |
| <b>4a</b>  | <b>Labor used to remove sludge by water from bottom valve- minutes</b>  | <b>0.0</b>              | <b>17.0</b>           | <b>4.0</b>              |
| <b>5</b>   | <b>Water used to clean the tank in liters</b>   | <b>18.60</b>            | <b>111.60</b>         | <b>93.0</b>             |
| <b>5a</b>  | <b>Labour used to clean the tank by water-in minutes</b>  | <b>1.0</b>              | <b>6.0</b>            | <b>5.0</b>              |
| <b>6</b>   | <b>Inside coagulated rubber removed- in Kg</b>  | <b>0.055</b>            | <b>7.560</b>          | <b>4.300</b>            |
| <b>6b</b>  | <b>% of Inside coagulated rubber removed-</b>   | <b>0.0034</b>           | <b>0.1837</b>         | <b>0.0756</b>           |
| <b>6c</b>  | <b>Labour used to remove inside coagulated rubber - in minutes</b>  | <b>10.0</b>             | <b>135.0</b>          | <b>122.0</b>            |
| <b>Summary of Datas</b>  |   |                         |                       |                         |
| <b>A</b>   | <b>% of Field Latex sent for centrifuging- (Yield)</b>  | <b>100</b>              | <b>90</b>             | <b>94</b>               |
| <b>B</b>   | <b>Total labour usage for the process-in minutes</b>  | <b>12.0</b>             | <b>183.0</b>          | <b>191.0</b>            |
| <b>B1</b>  | <b>% of Total labour usage per Wet Kg for the process-</b>  | <b>0.74</b>             | <b>4.45</b>           | <b>3.36</b>             |
| <b>C</b>   | <b>Total water usage for the process-in liters</b>  | <b>18.60</b>            | <b>427.80</b>         | <b>167.40</b>           |
| <b>C1</b>  | <b>% of Total water usage per Wet Kg for the process-</b>   | <b>1.14</b>             | <b>10.39</b>          | <b>2.94</b>             |
| <b>D</b>   | <b>% of Resources used per wet Kg-( compressed air, hoses etc)</b>  | <b>0</b>                | <b>0.92</b>           | <b>1.09</b>             |
| <b>E</b>   | <b>Work load to Waste Water Treatment Plant in Kg</b>   | <b>0</b>                | <b>105.54</b>         | <b>49.78</b>            |
| <b>F</b>   | <b>Reduction of Sulpuric usage</b>  | <b>No analysis made</b> |                       |                         |
| <b>G</b>   | <b>Reduction of Resources utilized</b>  | <b>No analysis made</b> |                       |                         |
| <b>H</b>   | <b>Environmental enhancement</b>  | <b>No analysis made</b> |                       |                         |

**4. Objectives achieved to date:**

Completed the project according to the project proposal and achieved objective 1 and objective 2 successfully.

But required additional three months to complete the objective 2, due to technical difficulties aroused during production of mould and discussed that further in item 7 in this report as "Deviations to the work plan when compared to the original proposal, if any".

**5. Discussion results and observations****5.1. Discussion results and observations of objective 1 on Centrifuged latex maturation process:**

5.1.1. The analytical parameters such as alkalinity (as ammonia), MST, VFA No and KOH number is tested once in 5 days to check quality variation of centrifuged latex during the maturation period and all they were within the acceptable tolerances in both tanks.

5.1.2. No measurements were taken to analyze the energy savings during these control tests.

The control tests carried out for centrifuged latex maturation process using conventional cylindrical tanks versus invented ecodeigned spherical tank shows the advantages of the spherical tank process as follows.

5.1.3. The spherical container reduced skin rubber formation due to its less internal surface area and spherical shape.

5.1.4. Its spherical shape having no edges or corners reduced the froth and coagulated rubber formation and improved the resource productivity without any additional cost.

5.1.5. The spherical shape of the tank make way to automatically rise up the formed froth to Mouth during latex processing's hence facilitating to remove them easily.

5.1.6. New ammonia injection methodology by means of a nozzles assembly which fixed at the bottom of spherical tank, ensured efficient mixing of ammonia with latex.

5.1.7. Spherical tank retained ammonia hence minimizes ammonia evaporation to environment providing environmental friendly working surrounding for factory staff and it further prevents environment pollution and arising serious problems with neighborhoods of the industry and government authorities. But No value for this has added for the final figure of savings.

5.1.8. The shape of spherical container itself helps to collect left over rubber at the bottom of the tank hence reduces the cost on labor, materials and utensils during tank cleaning process.

5.1.9. At the end of maturation period-the matured latex which transferred to next maturation tank for rework is a loss to the company. Because it has absorbed chemicals, energy, ammonia, labor and space which all are money. This is mainly due to poor design of the out let and inefficient stirrer arrangement. These problems have effectively addressed by the design of spherical tank and hence there is an additional saving of LKR 1090.27/= per metric ton when calculated.

(Saving per metric ton 3.6342 Kg @ average existing selling price as Rs:300/ =LKR 1090.27)

**5.2. Discussion results and observations of objective 2 on Field latex bulking process:**

**5.2.1. No measurements were taken to Analyze**

Reduction of waste load to Waste Water Treatment Plant,  
Reduction of Sulfuric acid usage during degraded crepe rubber production,  
Reduction of energy usage,  
Environmental enhancement-etc: during these control tests.

The control tests carried out for field latex bulking process using conventional rectangular tank, and cylindrical tank having conical bottom versus invented ecodedesigned spherical tank shows the advantages of the spherical tank process as follows.

5.2.2. The spherical container reduced skin rubber formation due to its less internal surface area and spherical shape.

5.2.3. The shape of spherical container itself helps to collect sludge at the bottom of the tank hence reduces the cost on labor, materials and utensils during tank cleaning process.

5.2.4. At the end of bulking process-the field latex which transferred to next bulking tank for rework is a loss to the company. Because it has absorbed chemicals, compressed air, pumps, hoses, labor and space which all are money. This is mainly due to poor design of the out let valve and inefficient sludge separation arrangement. These problems have effectively addressed by the design of spherical tank and its valve system hence there is an additional saving when calculated.

5.2.5. When this new technology is implemented, the cost suffered by the factory on compressed air generation and usage will be eliminated as rework eradicated.



**Final evaluation visit of National Science Foundation**

**6. Output arising from the project:**

**6.1. Processing Cost Savings**

The control tests of this project which carried out under the technical collaboration of Rubber Research Institute of Sri Lanka. by comparing conventional cylindrical tank and ecodesigned spherical tank revealed -the Percentage of latex saving on coagulated rubber as 42%, savings on Ammonia usage as 19.5% and savings on Labor usage as 59%.

Therefore according to the data obtained and results calculated by Mr.P. H. Sarath Kumara- Senior Manager – Technical (Latex Operation) of Lalan Rubbers - the annual cost savings which could be succeeded by the Lalan Rubbers Private Limited by implementation of technology of spherical container in their organization can be calculated as follows.

|           | <b>Description</b>  | <b>Cost saving per dry ton of centrifuged latex manufactured (in LKR)</b> |
|-----------|---|---|
| <b>1</b>  | Reduction of coagulated and skin rubber formation   | 121.08  |
| <b>2</b>  | Reduction of ammonia usage  | 44.32   |
| <b>3</b>  | Reduction of labor usage  | 73.33   |
| <b>4</b>  | Reduction of rework on matured latex  | 1090.27   |
| <b>5</b>  | Reduction of energy usage included compressed air consumption   | No provisions to calculate  |
| <b>6</b>  | Reduction of sulfuric acid usage during degraded crepe rubber production,   | No provisions to calculate  |
| <b>7</b>  | Reduction of utensils usage such as pumps, hoses, barrels, cleaning tools etc:  | No provisions to calculate  |
| <b>8</b>  | Reduction of waste load to Waste Water Treatment Plant  | No provisions to calculate  |
| <b>9</b>  | Improvement made to workers health through reduction of ammonia usage   | No provisions to calculate  |
| <b>10</b> | Environmental enhancement   | No provisions to calculate  |
| <b>11</b> | <b>Therefore total Saving (considered only the above calculated items )</b>   | <b>1329.00</b>  |
| <b>12</b> | Average Centrifuged latex production of Lalalan Rubbers per year = 6000 metric tons   |   |
| <b>13</b> | <b>Therefore annual saving could be achieved by Lalan Rubbers by implementing this new technology of spherical containers (considered only the above calculated items) = LKR 7,974,000.00</b> |   |

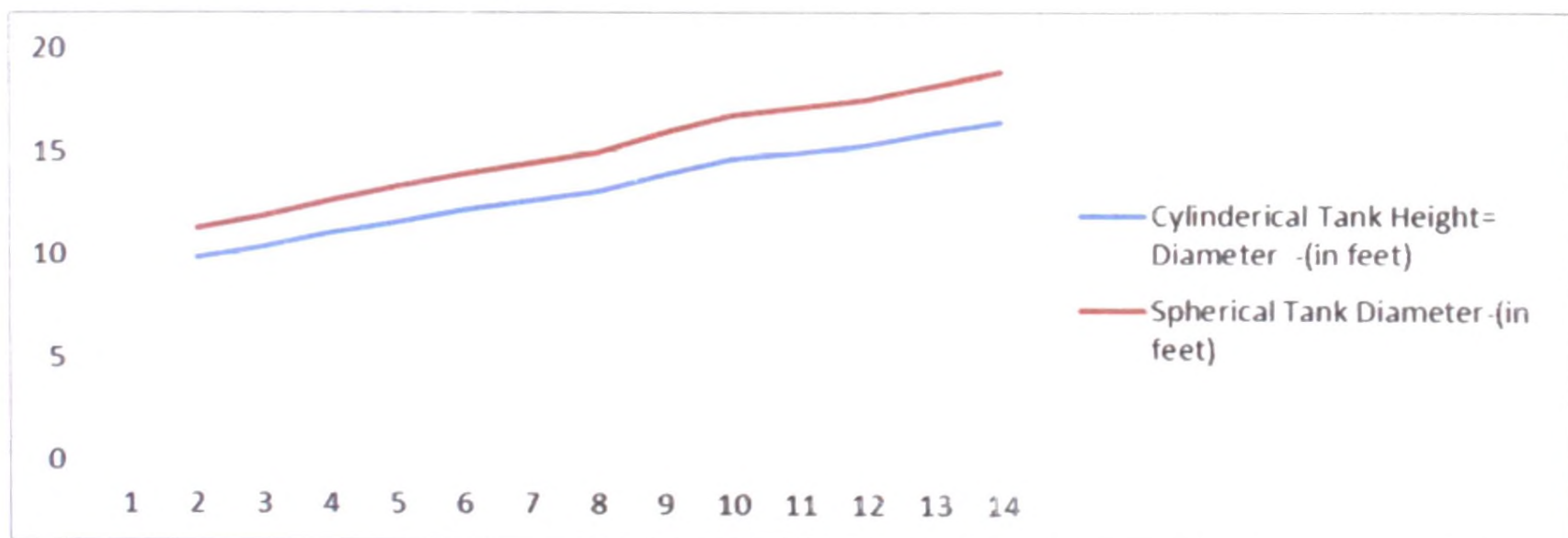
Therefore the above results establishes that introduction of this new technology of ecodesigned spherical tank for centrifuged latex production process will be a definite contribution for the sustainable development of future natural rubber centrifuged latex industry in Sri Lanka and World.

**6.2. Disadvantages of spherical container on space utilization:**

Volume of a spherical tank placed in a space –where a cylindrical tank could be placed vertically – then cylindrical tank utilizes 67.69% of that volume. Hence total space utilization by a spherical tank is higher when that compared to a vertically placed cylindrical tank. This is the only disadvantage that we have observed during the application of new technology of spherical container hence calculated the requirement of floor area for both these tanks according to following table.

**6.2.1 Space Requirement Calculations for Cylindrical Shape Container Vs: Spherical Container:**

| Volume in liters | Volume in Cu:m | For Cylindrical Shape Container<br>(Note: To build a minimum area Cylinder, the Diameter must be equal to Height.) |   | Required Diameter For Spherical Shape Container (In ft) | Difference (In Ft) | % Of Difference |
|------------------|----------------|--|---|---|--------------------|-----------------|
|                  |                | Diamete (in ft for Cylinder)   | Height of Cylinder = Diameter of Cylinder (in ft) |   |                    |                 |
| 21300            | 21.3           | 9.86   | 9.86  | 11.29   | 1.43               | 14.5            |
| 25000            | 25             | 10.40  | 10.40   | 11.90   | 1.50               | 14.4            |
| 30000            | 30             | 11.06  | 11.06   | 12.65   | 1.59               | 14.4            |
| 35000            | 35             | 11.63  | 11.63   | 13.31   | 1.68               | 14.5            |
| 40000            | 40             | 12.17  | 12.17   | 13.92   | 1.76               | 14.4            |
| 45000            | 45             | 12.65  | 12.65   | 14.48   | 1.83               | 14.5            |
| 50000            | 50             | 13.10  | 13.10   | 15.00   | 1.89               | 14.4            |
| 60000            | 60             | 13.92  | 13.92   | 15.94   | 2.02               | 14.5            |
| 70000            | 70             | 14.66  | 14.66   | 16.78   | 2.12               | 14.5            |
| 75000            | 75             | 15.00  | 15.00   | 17.17   | 2.17               | 14.5            |
| 80000            | 80             | 15.32  | 15.32   | 17.54   | 2.22               | 14.5            |
| 90000            | 90             | 15.94  | 15.94   | 18.24   | 2.31               | 14.5            |
| 100000           | 100            | 16.51  | 16.51   | 18.90   | 2.39               | 14.5            |



**Disadvantage of requirement of additional factory floor area:** According to above calculations the requirement of additional production floor area for spherical container is only 14.5% higher than the conventional cylindrical tank. But when compared with the earlier said many advantages in the new technology of spherical container application, the impression of space utilization will be negligible. Furthermore the centrifuge latex factories are to be establishing in rural areas where land values are comparatively less. If we are to build a centrifuge factory somewhere in the populated main cities then disadvantage of space utilization may take in to consideration but that also will be negligible when compared with endless savings specified by the technology of spherical container.

**7. Deviations to the work plan when compared to the original proposal, if any. Please justify your deviations and state whether you got the prior approval from NSF for such deviation. (state references)**

Production of the Rotomould initiated by assembling a Hydraulic Press Machine and then making a Female Die and Male Die. Then hydraulically pressed several hemispheres using said Female Die and a Male Die by 02 mm thick Mild Steel Sheets. But observed deformations and wrinkles on all the pressed hemispheres where we were not able to rectify these defects anyhow.

Therefore informed the above problem to technologist of RPC Polymers -Industrial Partner, and request their permission to increase the thickness of the rotomould up to 04mm, in order to overcome the deformations and wrinkles. But they were not agreed to increase the thickness of the mould due to uneven heat transfer problems may arises in the LLDPE TANKS during their factory production process. So started to make a 1400 liter Rotomould by Foundry Method and it was also failed due to formation of unlimited blowholes. (First to make a Waththu Mala and then form a 02mm Mold-Method)

Finally the fabrication of rotomould completed successfully, by using sheet metal fabrication methodology but required additional three months to complete the project by exceeding the specified time limits mentioned in the original work plan and Gantt chart. I informed those technical difficulties to NSF and obtained prior approval by their letter reference TD/dnw dated 03.04. 2014.

**8. Whether the work was on schedule? If not, give reasons.**

**Objective 1.**

**Design and fabrication of spherical tank of around 22500 liter capacity to be used as field latex bulking tank and centrifuged latex maturation tank. (capacity match to export of one container load of centrifuge latex)**

Volume of the fabricated spherical tank: The original design was to fabricate a 22500 liter tank where the capacity matches to export one container load of centrifuge latex. But after the completion of fabrication work - it end up with about 21300 liter capacity mild steel spherical tank. Therefore the accuracy of the fabrication work is around 95%. Tried to recover the deviation of the volume back using available mechanical instruments but it was impossible. This could be overcome if we arranged to join the University of Moratuwa as a Team Member attached to this project and work under their supervision.

**9. Major items equipment/consumables & material purchased during the reporting period:**  
None

**10. Problems if any, encountered during the implementation of the project:**

**10.1 Obtaining an accurate evaluation report:**

As the technology of spherical container is a new product and a process, the accuracy of the evaluation report completely depends on the data's provided by the factory personal that handled the production processes and control tests. But it was very difficult to keep their minds free from existing keep Performance Indicators they used in their industrial production processes while attending the data collection of control tests. This may be affected the final evaluation report and that could be overcome if we arranged to join the Rubber Research Institute as a Team Member attached to this project and employed two research assistants to work under their supervision.

**11. Proposed follow up action regarding output**

**Objective 1.**

**Design and fabrication of spherical tank of around 22500 liter capacity to be used as centrifuged latex maturation tank. (Capacity match to export one container load):**

The Lalan Rubbers (Pvt) Limited-at Algama Road, Horagasmankada-Sri Lanka, expressed their consent to apply this invented technology of ecodesign spherical to their industry during their next factory production development stage.

**Objective 2.**

**Design and fabrication of a mould for roto-moulding process, to mass produce transportable spherical tanks of around 1400 liter, to be used for rubber latex transportation in-between plantation and latex processing factory and similar applications.( capacity match to one cycle of centrifuging machinery involvement in centrifuge latex production):**

The Industrial Partner - RPC Polymers at Horana-poruwadanda Industrial Estate, which comes under the Richard Peiris and Company of Sri Lanka, expressed their consent to carry out the serial production of these LLDPE spherical tanks and to use their island wide distribution channels in marketing the product, after signing an agreement with them.

Further hope to apply for the individual patents in Asia Pacific Countries -which contributes 94% altogether to the world natural rubber production and to make arrangements to conduct the technology transfer sessions for them.

**D) Comments regarding project implementation, if any**

**1. Failure of fabrication of Rotomould with in the specified time limits:**

The failure of fabrication of Rotomould with in the specified time limits mentioned in the original work plan and Gantt chart were occurred due to absence of an accurate designing and engineering methodology and that could be overcome if we arranged to join the University of Moratuwa as a Team Member attached to this project and employed two final year students work under their supervision.

**2. Additional Expenditure:** The additional expenditures in this project that inventor had to bear were as follows,

|   | <b>Description</b>   | <b>Expenditure LKR</b> |
|---|--|------------------------|
| 1 | Government Taxes for fabrication works                               | 471,240.00             |
| 2 | Transport cost of the 22500 liter spherical to Lalan –Horagasmankada | 50,000.00              |
| 3 | Cost of the Foundation work for Spherical tank at Lalan Rubbers      | 197,635.00             |
| 4 | Roof and working Flat form construction cost at Lalan Rubbers        | 188,160.00             |
| 5 | Cost of the Ammonia gas line installation at Lalan Rubbers           | 88,684.00              |
| 6 | Cost of the Electricity supply at Lalan Rubbers                      | 14,741.42              |
| 7 | <b>Total Additional Expenditure beard by Inventor</b>                | <b>1,010,460.42</b>    |

*T. Sunil's. Gomes*

Signature of the Project Team Leader T.S.S.Gomes

... 2014.09.10.....  
Date

## **Attachments**

|   | <b>Description</b>  | <b>Page</b>      |
|---|---|------------------|
| 1 | <b>Evaluation report of Mr.P. H. Sarath Kumara-Senior Manager<br/>- Technical (Latex Operation) - Lalan Rubbers (pvt) Ltd</b> | <b>37 and 38</b> |
| 2 | <b>Schedule E -Final financial report- Signed 14.09.2014</b>  | <b>39</b>        |
| 3 | <b>Final financial report- Payments up to 30.06. 2014</b>   | <b>40</b>        |
| 4 | <b>Engineering Drawing of 1400 liter -Spherical Rotomold</b>  | <b>41</b>        |
| 5 | <b>Engineering Drawing of Lid of 1400 liter -Spherical Rotomold</b>   | <b>42</b>        |
| 6 | <b>Engineering Drawing of 22500 liter -Spherical Tank</b>   | <b>43</b>        |
|   |   |                  |

LALAN RUBBERS (PVT) LTD

No 18, Nawala Road  
Nugegoda

02 July 2014

**EVALUATION OF PERFORMANCE OF SPHERICAL LATEX STORAGE TANK**  
introduced by Mr. Gomes

A comparison was made using latex from same batches to fill both spherical tank and a conventional storage tank with a closer capacity in the 1<sup>st</sup> trial study. We had a second run but without comparison with a conventional tank. The results of the 2<sup>nd</sup> run too came very close to that obtained in the 1<sup>st</sup> run.

Summary of comparisons is as follows;

| Description  | Conventional<br>Cylindrical Tank<br>(Horizontally placed) | Spherical Tank |
|--|---|----------------|
| <b>Wet weight of latex stored (m3)</b>                                       | <b>23.783</b>   | <b>20.553</b>  |
| <b>Dry weight of latex (Tonnes)</b>  | <b>13.74</b>  | <b>11.89</b>   |
| Ammonia Incorporated (kg)  | 131.5   | 114            |
| Ammonia incorporated per dry tonne (kg)                                      | 9.57  | 9.59           |
| Ammonia Retained (kg)  | 117.6   | 104.3          |
| Loss of ammonia (kg)   | 13.9  | 9.7            |
| Loss of ammonia (%)  | 10.57   | 8.51           |
| Saving of Ammonia (%)  |   | 2.06           |
| <b>Coagulated and Left over rubber (dry kg)</b>                              | <b>27.84</b>  | <b>14.5</b>    |
| <b>Percentage of Coagulated and Left over rubber on dry rubber input (%)</b> | <b>0.2</b>  | <b>0.12</b>    |
| Labour hours for cleaning  | 535 minutes   | 205 minutes    |
| Labour hours for transfer of remaining latex and coagulum                    | 144 minutes   | 57 minutes     |
| <b>Labour saving (percentage)</b>  | -   | <b>59%</b>     |
| <b>Cost savings per dry tonne of centrifuged latex manufactured (in LKR)</b> |   |                |
| <b>Coagulated and left over rubber</b>                                       |   | <b>121.08</b>  |
| <b>Ammonia</b>   |   | <b>44.32</b>   |
| <b>Labour</b>  |   | <b>73.33</b>   |
| <b>Total</b>   |   | <b>238.73</b>  |

Latex in the two tanks was kept under identical conditions. Stirring was done at the same time for 10 minutes on a daily basis.

**It can be seen from above data that percentage loss of ammonia has been reduced in the spherical tank which is a definite economical advantage. Also reduction of escape of ammonia into the environment will reduce the environmental hazards to a certain extent.**

Loss of rubber in the tank as coagulum is also reduced. Since uncoagulated rubber as latex fetches a higher price over coagulated rubber, this is also a significant economical advantage.

Volume of a spherical tank placed in a space where a cylindrical tank could be placed vertically, is 67.69% of the cylindrical tank volume. Hence space utilisation by a spherical tank is 2/3 of that compared to a vertically placed cylindrical tank. This is the only disadvantage that we have observed.

**Although property changes of latex over the storage period in conventional tank and the spherical tank were identical, it should be further studied.**

P. H. Sarath Kumara  
Senior Manager – Technical (Latex Operation)

Schedule E

Format for Interim and Final Financial Report

The financial position of grant No. TG/2012/Tech-D/02 as at 31.06.2014 awarded to Mr/Dr./Prof. R. S. S. Gomes by National Science Foundation is as follows.

|  | Funds received<br>By the Univ./<br>Institution | Total<br>expenditure<br>RS. | Balance<br>available<br>RS. |
|--|--|-----------------------------|-----------------------------|
| Personal- Consultants  | .....  | .....                       | .....                       |
| Technical Assistant  | .....  | .....                       | .....                       |
| Labourer   | .....  | .....                       | .....                       |
| Other  | .....  | .....                       | .....                       |
| Equipment- Foreign<br>(Items<br>Purchased<br>Should be<br>Stated)      Local | .....  | .....                       | .....                       |
| Consumables and materials<br>Foreign   | .....  | .....                       | .....                       |
| Local  | .....  | .....                       | .....                       |
| <u>Design and Fabrication</u>  | <u>2,253,466.62</u>                            | <u>2,253,466.62</u>         | <u>Nil</u>                  |
| <del>Travel &amp; Subsistence</del>  |  |                             |                             |
| Equipment hiring charges   | <u>8,400.00</u>                                | <u>8,400.00</u>             | <u>Nil</u>                  |
| Test Trails  | <u>12,600.00</u>                               | <u>12,600.00</u>            | <u>Nil</u>                  |
| Miscellaneous - Bank Interest  | <u>1,628.14</u>                                | <u>1,628.14</u>             | <u>Nil</u>                  |
| <b>TOTAL</b>   | <b>2,276,094.76</b>                            | <b>2,276,094.76</b>         | <b>Nil</b>                  |

Unspent balance of the funds received

|                           |  |
|---------------------------|--|
| Funds received            | - RS. <u>2,274,466.62 + Bank Interest 1628.14 = 2,276,094.76</u> |
| Actual expenditure        | - <u>2,276,094.76</u>  |
| Balance                   | <u>Nil</u>   |
| Cash Imprest/Cash advance | - .....  |
| Balance as at             | <u>2014.06.31</u>  |

J. Suril's. Jones  
Bursar/Accountant (Guarantee)

Date: 2014.09.14.



| Objective 1              | Payments upto 30.06.2014 |            |                 |                     |                     |                     | Paid to                             |
|--------------------------|--------------------------|------------|-----------------|---------------------|---------------------|---------------------|-------------------------------------|
|                          | Payble                   | Date       | Paid by         |                     | Total Paid          |                     |                                     |
|                          |                          |            | Bank Interest   | NSF                 |                     |                     |                                     |
| Design & Fabrication     | 2,530,000.00             | 09.05.2013 |                 | 1,000,000.00        | 428,571.43          | 1,428,571.43        | GBSS                                |
| 14% Taxes                | 354,200.00               | 10.06.2013 |                 | 62,600.00           | 26,828.57           | 89,428.57           | GBSS                                |
| Payble to GBSS           | 2,884,200.00             | 22.11.2013 | 1,622.88        | 692,116.62          | 672,460.50          | 1,366,200.00        | GBSS                                |
| Hiring                   | 6,000.00                 | 26.10.2013 |                 | 4,200.00            | 3,300.00            | 7,500.00            | Gamini-Dan Owita(Additional 1500/-) |
| Test trials              | 18,000.00                | 18.12.2013 |                 | 12,600.00           | 5,400.00            | 18,000.00           | GBSS                                |
| <b>Total</b>             | <b>2,908,200.00</b>      |            | <b>1,622.88</b> | <b>1,771,516.62</b> | <b>1,136,560.50</b> | <b>2,909,700.00</b> |                                     |
| Transport                |                          | 26.10.2013 |                 |                     | 50,000.00           | 50,000.00           | GBSS                                |
| Foundation               |                          | 22.11.2013 |                 |                     | 197,635.00          | 197,635.00          | Leelarathna                         |
| Roof & Flatfom           |                          | 22.11.2013 |                 |                     | 188,160.00          | 188,160.00          | Shantha                             |
| Ammonia Supply           |                          | 22.11.2013 |                 |                     | 88,684.00           | 88,684.00           | GBSS                                |
| Electricity Supply       |                          | 22.11.2013 |                 |                     | 14,741.42           | 14,741.42           |                                     |
| <b>Grand Total</b>       |                          |            | <b>1,622.88</b> | <b>1,771,516.62</b> | <b>1,675,780.92</b> | <b>3,448,920.42</b> |                                     |
| %                        |                          |            | <b>0.05</b>     | <b>51.36</b>        | <b>48.59</b>        | <b>100.00</b>       |                                     |
|                          |                          |            |                 |                     |                     | -                   |                                     |
| <b>Objective 2</b>       |                          |            |                 |                     |                     | -                   |                                     |
|                          |                          |            |                 |                     |                     | -                   |                                     |
| Design & Fabrication     | 836,000.00               | 10.06.2013 |                 | 190,400.00          | 81,600.00           | 272,000.00          | GBSS                                |
| 14% Taxes                | 117,040.00               | 12.06.2014 |                 | 302,050.00          | 378,990.00          | 681,040.00          | GBSS                                |
| Payble to GBSS           | 953,040.00               |            |                 |                     |                     | -                   |                                     |
| Hiring                   | 6,000.00                 | 12.06.2014 | 5.26            | 2,100.00            | 3,894.74            | 6,000.00            | Premalal                            |
| Test trials              | 12,000.00                | 12.06.2014 |                 | 8,400.00            | 3,600.00            | 12,000.00           | GBSS                                |
| <b>Grand Total</b>       | <b>971,040.00</b>        |            | <b>5.26</b>     | <b>502,950.00</b>   | <b>468,084.74</b>   | <b>971,040.00</b>   |                                     |
| %                        |                          |            |                 | <b>51.79</b>        | <b>48.20</b>        | <b>100.00</b>       |                                     |
| <b>Ob 1 + Ob 2</b>       |                          |            |                 |                     |                     | -                   |                                     |
| <b>Final Grand Total</b> | <b>3,879,240.00</b>      |            | <b>1,628.14</b> | <b>2,274,466.62</b> | <b>2,143,865.66</b> | <b>4,419,960.42</b> |                                     |
| %                        |                          |            | <b>0.04</b>     | <b>51.46</b>        | <b>48.50</b>        | <b>100.00</b>       |                                     |

| Objectives 1+2: Funds released by NSF up to 2014.06.30 |                     |                   |                   |                   |                     |
|--|---------------------|-------------------|-------------------|-------------------|---------------------|
| Date   | 30.04.2013          | 10.05.2013        | 18.11.2013        | 09.06.2014        | Total               |
| Design, fabrication                                    | 1,000,000.00        | 253,559.00        | 689,457.62        | 310,450.00        | 2,253,466.62        |
| Test trials  |                     | 12,600.00         |                   |                   | 12,600.00           |
| Equipment hiring charges                               |                     | 4,200.00          | 2,100.00          | 2,100.00          | 8,400.00            |
| <b>Total</b>   | <b>1,000,000.00</b> | <b>270,359.00</b> | <b>691,557.62</b> | <b>312,550.00</b> | <b>2,274,466.62</b> |

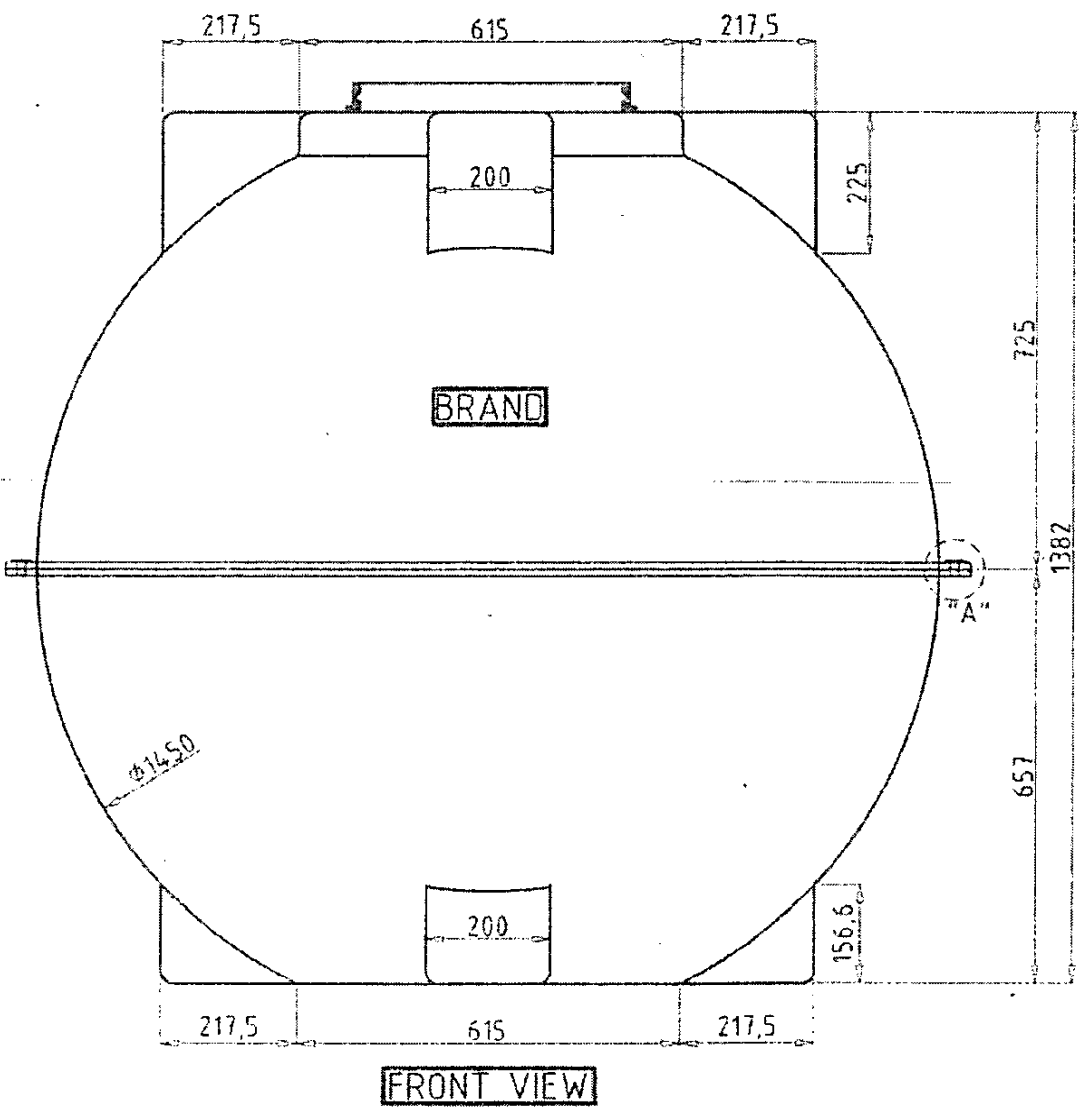
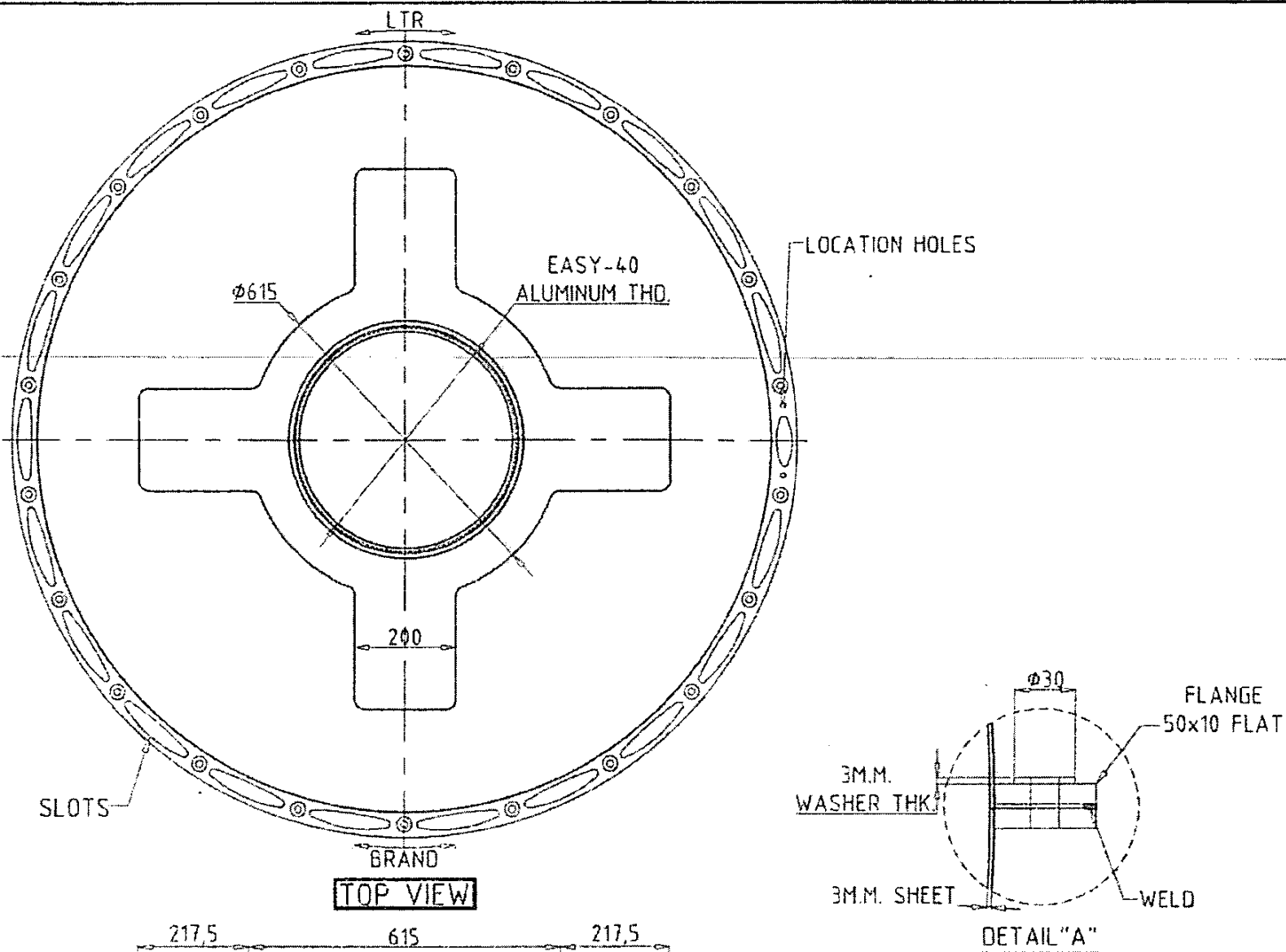
*T. S. S. Gomes*

Signed by T.S.S.Gomes

Grantee

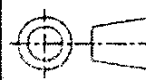
2014.07.02

\* EXCEPT DIAMETER & HEIGHT DIMENSIONS ARE SHOWN FOR REFERENCE ONLY AND IT MAY VARY.



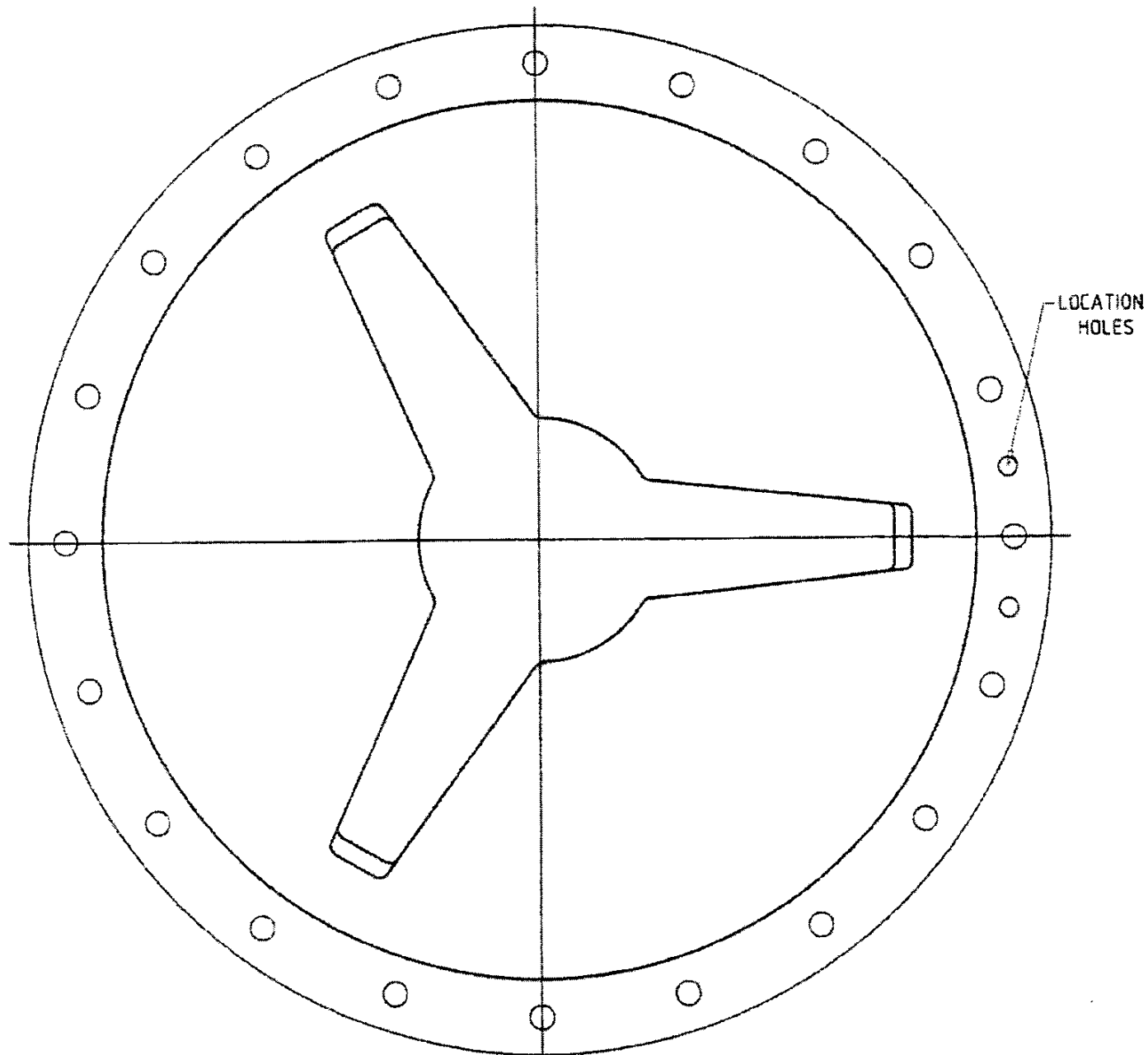
\* ALL DIMENSIONS ARE IN M.M.  
\* THIS IS MOULD INSIDE DIMENSION.

- \* THD. CONE HOPPER.
- \* BRAND ON FRONT SIDE.
- \* LTR PLATE ON BRAND OPPOSITE SIDE.
- \* CLAMP :- 19 NOS.
- \* FLAT :- 50X10
- \* DOWEL PIN - 04 NOS.
- \* CAPACITY :- CLIENT'S DIMENSIONS.
- \* CARRIER :- BI-AXIAL.

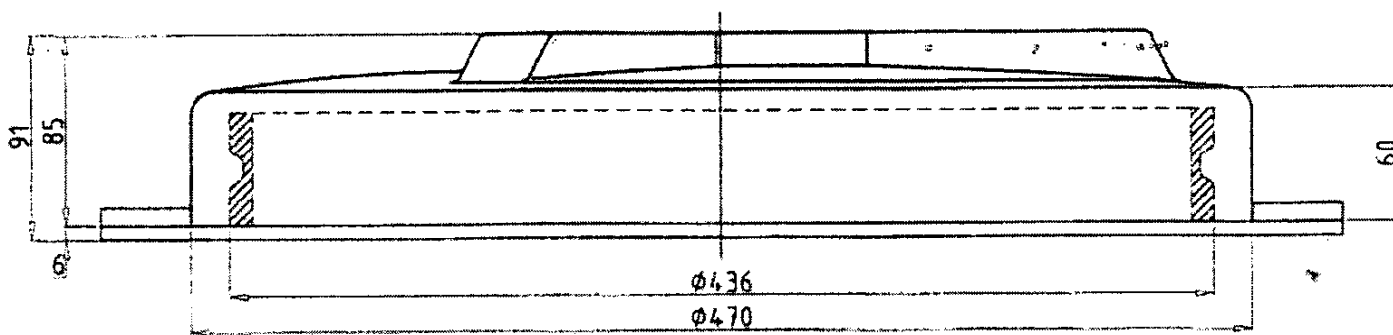
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| <b>GREEN BUSINESS SUPPORT SERVICES</b> |       |   |                          |
| DRN BY:                                | P.N.S | SYMBOL  | TITLE:                   |
| CHD BY:                                |       |  | <b>1400LTR SPHERICAL</b> |
| APPR BY:                               |       |   | SCALE: NTS               |
| DATE :- 02/01/2014.                    |       | DSN REVI. NO: 00  |                          |
| C. CODE: GBS-ES.                       |       | QTY:  | MAT.:                    |
|  |       | 01 NO.  | M.S. 10SWG.              |

| TOLERANCE              |
|------------------------|
| 0-500 mm :- ±0.5%      |
| 501-1000 mm :- ±0.4%   |
| 1001 mm TO UP :- ±0.3% |

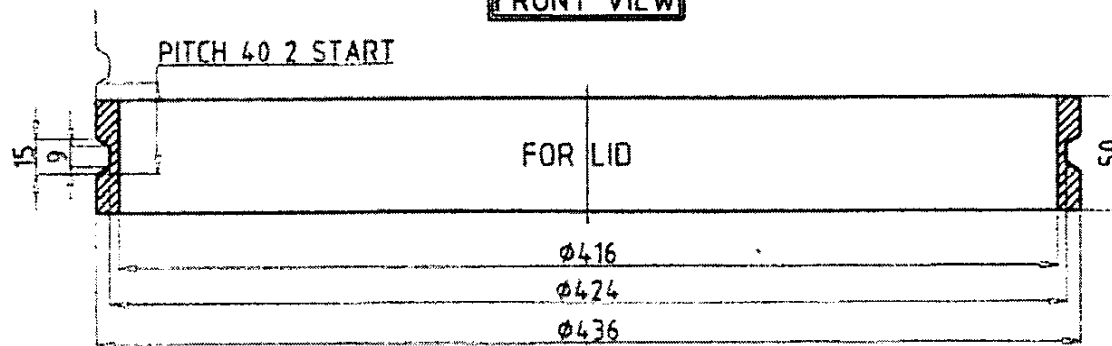
\* EXCEPT DIAMETER & HEIGHT DIMENSIONS ARE SHOWN FOR REFERENCE ONLY AND IT MAY VARY.



TOP VIEW



FRONT VIEW



LID THD.

\* DOWEL PIN:-03 NOS.  
\* FLAT:-40x08.

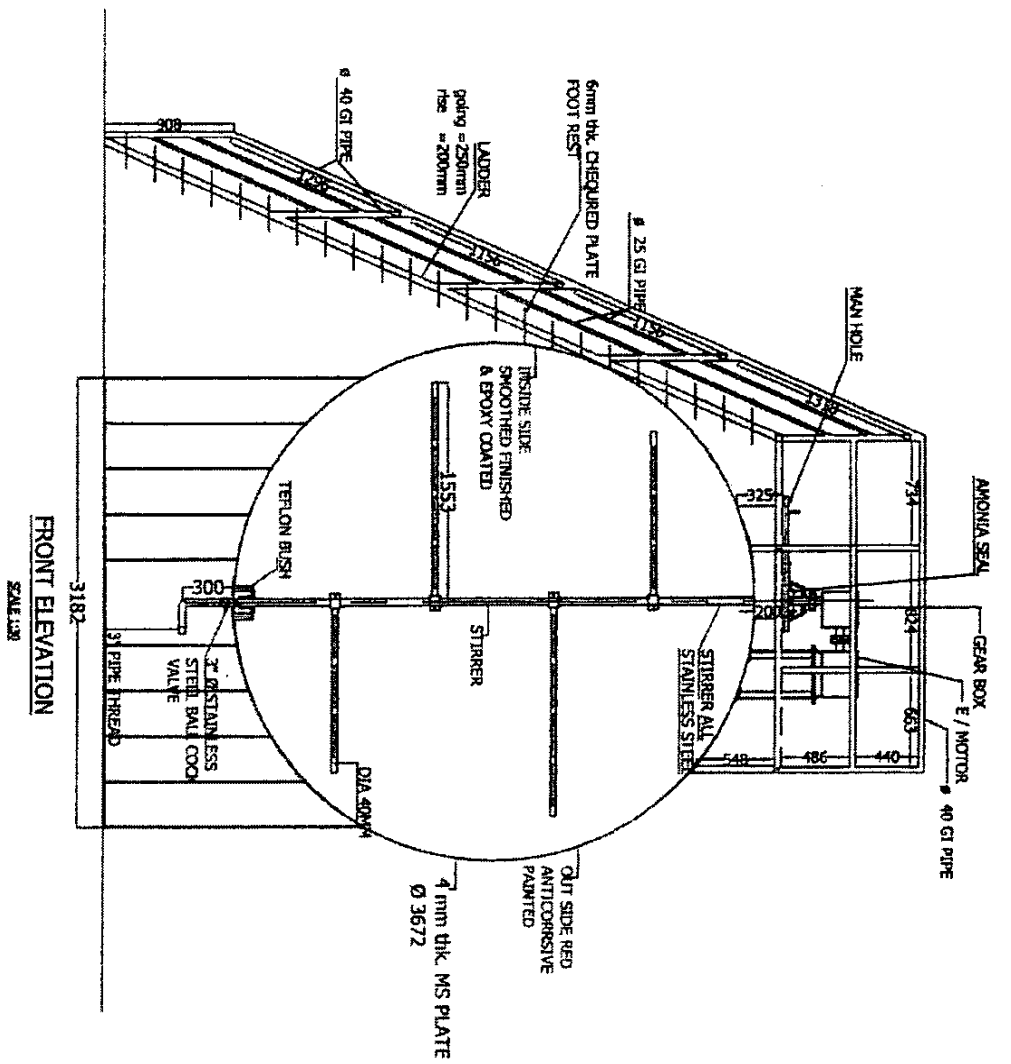
**GREEN BUSINESS SUPPORT SERVICES**

|          |       |        |                            |
|----------|-------|--------|----------------------------|
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| CHD BY:  |       |        | LID COVER                  |
| APPR BY: |       |        | SCALE: NTS                 |

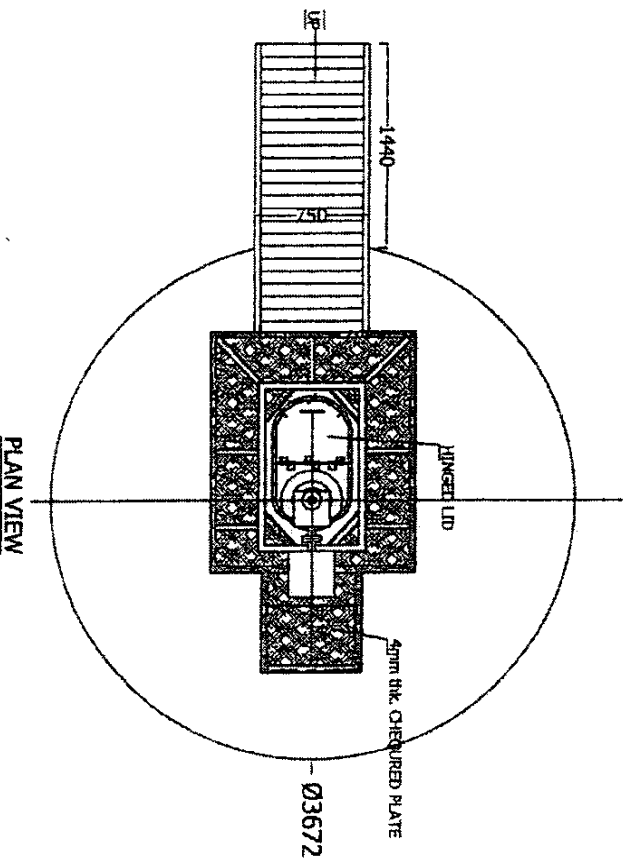
|                     |             |                  |                  |
|---------------------|-------------|------------------|------------------|
| DATE :- 02/01/2014. | QTY: 01 NO. | DSN REVI. NO: 00 | MAT: M.S. 14SWG. |
| C. CODE: GBS-ES.    |             |                  |                  |

| TOLERANCE                    |
|------------------------------|
| 0-500 mm :- $\pm 0.5\%$      |
| 501-1000 mm :- $\pm 0.4\%$   |
| 1001 mm TO UP :- $\pm 0.3\%$ |

\* ALL DIMENSIONS ARE IN M.M.  
\* THIS IS MOULD INSIDE DIMENSION.

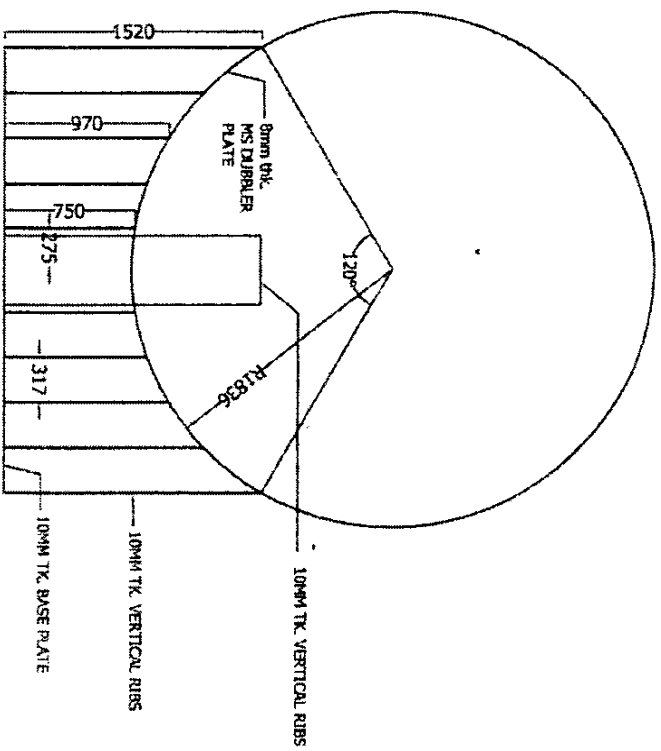


FRONT ELEVATION  
SCALE 1:20

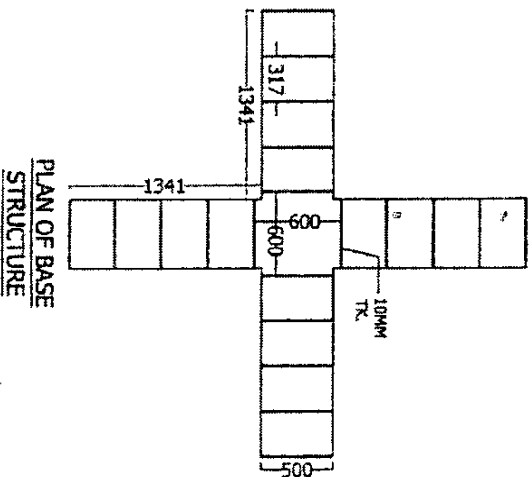


PLAN VIEW

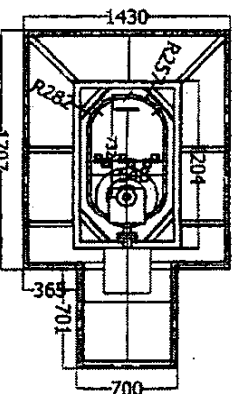
GENERAL ARRANGMENT OF LATEX TANK



FRONT ELEVATION OF  
BASE STRUCTURE

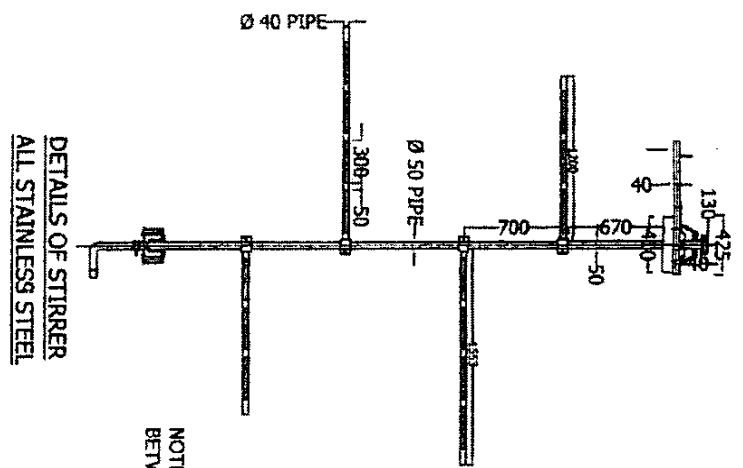


PLAN OF BASE  
STRUCTURE



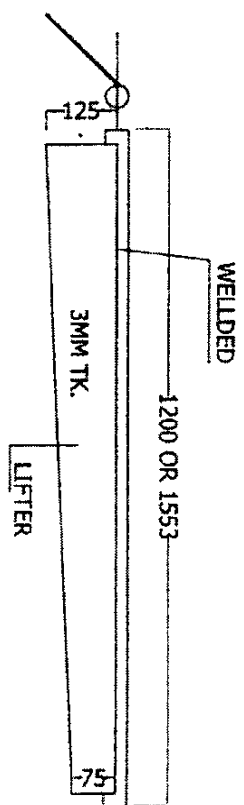
PLAN VIEW

STRUCTURAL DETAILS OF PLATFORM

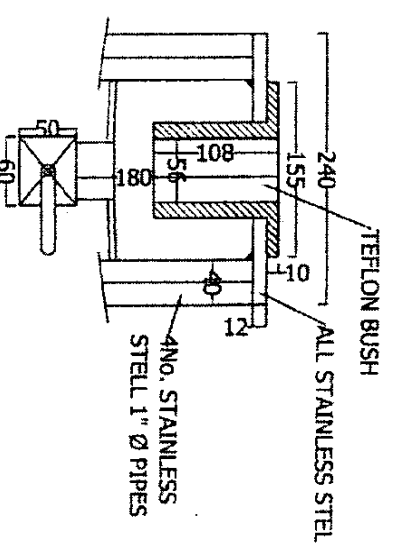


DETAILS OF STIRBER  
ALL STAINLESS STEEL

NOTE :- THRUSTER CONTROLLED RPM  
BETWEEN 5-25



DETAIL OF STIRER



TEFLON BUSH DETAILS

PROJECT :- ECO DESIGNED CENTRIFUGED LATEX MATURATION TANK  
INVENTOR & PATENT HOLDER :- MR. T.S.S GOMES  
SI. PATENT NO: 1442/15/13

1782F  
UMAGILYA PLACE  
NUNGAMUGODDA,  
KELANTAY,  
SEI ANEKA - mobile: 0714913737  
20th MARCH 2013

**National Digitization Project**  
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