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Optimization of Vacuum Pressurised Impregnation Plant

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ABSTRACT : The one of the long term contributors to electric motors. The highest industry standard for motor packaging is through a process called VPI (vacuum impregnation). This state-of-the-art method is only used for less than 10% of world production of standard engines and is mainly used for extremely heavy applications. This process has helped end users significantly reduce engine failures. The following research focuses on the possibility of optimizing VPI plants for better production.

Six control parameters have been selected for the optimization the VPI plant and Taguchi's experimental design has been selected for finding the influencing function of the control parameters.

I. INTRODUCTION

Organisation and product nature

Aqua Machineries Pvt Ltd is a leading Indian manufacturer of Heavy Duty Water Pumps & Wastewater pumps. Its products are thoroughly engineered withstand the less than Idealistic operating conditions often encountered in developing countries. Hence in real life conditions, they outperform equipment from the developed countries.

Heavy duty Non Clog Sewage Submersible Pumps, Portable Submersible Non Clog Manhole Sewage Pumps, Compact Submersible Non Clog Pumps, Non Clog Flood Proof Pump sets, Submersible Dredging and Slurry Pumps, Submerged Centrifugal Pump sets, Submersible Slurry Pumps.

Vacuum Pressurised Impregnation Plant

Vacuum pressure impregnation is a system in which vacuum and pressure are used to aid the penetration of liquids in various equipment. It is commonly used to impregnate electrical equipment with insulating resin because it only requires a VPI cycle to provide almost empty insulation.

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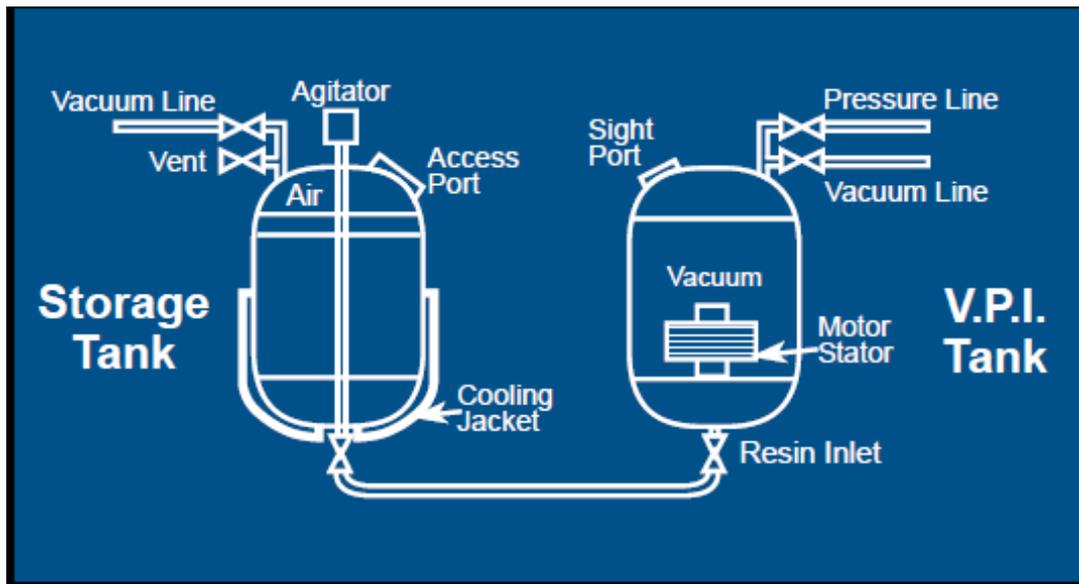


Fig..1 Vacuum Pressurised Impregnation Plant

VPI Cycle

It should change depending on the VPI device and the hardware and hardware. The material to be treated must be green (untreated) and must not be cured, open or swollen to remove the needles. Thermosetting resins should not be used

Stage 1 (Preheat)

Put the slices in the oven and preheat to 250-325 degrees Fahrenheit. Preheating is used to absorb moisture and oils easily. It improves reliability and completeness by reducing the visibility of the resin around the resin plate, and results in annealing when the plate is immersed in the resin. Before proceeding to the next step, let it cool to 150 degrees Fahrenheit or lower.

Step 2 (Dry Vacuum)

After installing the part in the vacuum chamber, take a vacuum (usually 1-4 mm Hg) for 30 minutes. At this stage, the remaining air and moisture, oil etc....

Step 3 (Wet vacuum)

Quickly mixed, the resin was inserted into an open chamber and allowed to flow from the bottom to allow for depth. The resin should cover a depth of 1 cm. If there is a large amount of extraction during the vacuum, the resin injection time is reduced to allow air and gas to escape.

Hold the application gap for 20-60 minutes. Larger groups and groups tend to have longer explanations. For thick coils and narrow areas, continuous gaps increase the drag.

Step 4(Pressure cycle)

When the circulating wet vacuum is partially completed and the part is still completely submerged, pressurize at 90-100 psi with air for an hour or more. Note: Depending on the characteristics of the resin, an inert Guy may be required to bring the vacuum to atmospheric pressure. The wound devices will need to bring the vacuum to atmospheric pressure. It takes about 15 minutes per half turn of the tape from the wound device. Relieve the stress. If allowed to ripen in the atmosphere for 30-60 minutes, the structure of the thixotropic product will be greater.

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Step 5(Removal and drain)

Forget and remove any part or all of the liquid. A reduction in the rate of 4 cm per month or slowly should be used to achieve the uniform coating of the resin. Trash can occur beyond the storage trucks, so traps can be removed and returned to the reservoir. When pumping water, it should be inserted in one corner to facilitate the drainage of the plains. Thick areas can be eliminated, which can cause constipation. Drain the water until the base run. Follow the specific recommendations on the data sheet. When using thixotropic products, wait 1-2 hours or more after the flood to promote the retention of the pelvic floor during the procedure. It minimizes the thixotropic effect in the oven.

Step 6 (Bake)

Place the treated part in a fully preheated oven.

1 Proposed Methodology

From the survey of the VPI plant, six input parameters has been selected for the optimization of the plant. The input parameters are shown below.

Table 3.1 Levels of Input Parameter

| Operating Parameter | Level 1 | Level 2 | Level 3 |
|---------------------------|---------|---------|---------|
| Preheating Temp(degree C) | 100 | 120 | 140 |
| Preheating Time(min) | 40 | 60 | 80 |
| Vacuum Pump Pressure(bar) | 0.5 | 0.6 | 0.7 |
| Submerge Time(min) | 10 | 20 | 30 |
| Air Pressure(kg) | 1.5 | 2 | 2.5 |
| Air Pressure Time(min) | 5 | 8 | 10 |

The responses which has to be chosen are impregnated resin thickness, time to fill the body and total process time.

For the Above Experiment Taguchi's L18 Orthogonal Array has been used.

II. EXPERIMENTAL PROCEDURE

The company is making total five types of stator winding which are as follows. M-270, M-320, M-420, M-508 and M-580. Here the no represents the size of the casted body. From which M-270, M-320 and M-508 has been taken for the experiment as these are the most commonly and widely used body for the pumps.

The designs of the above mentioned body are as follows.

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Design of M-270

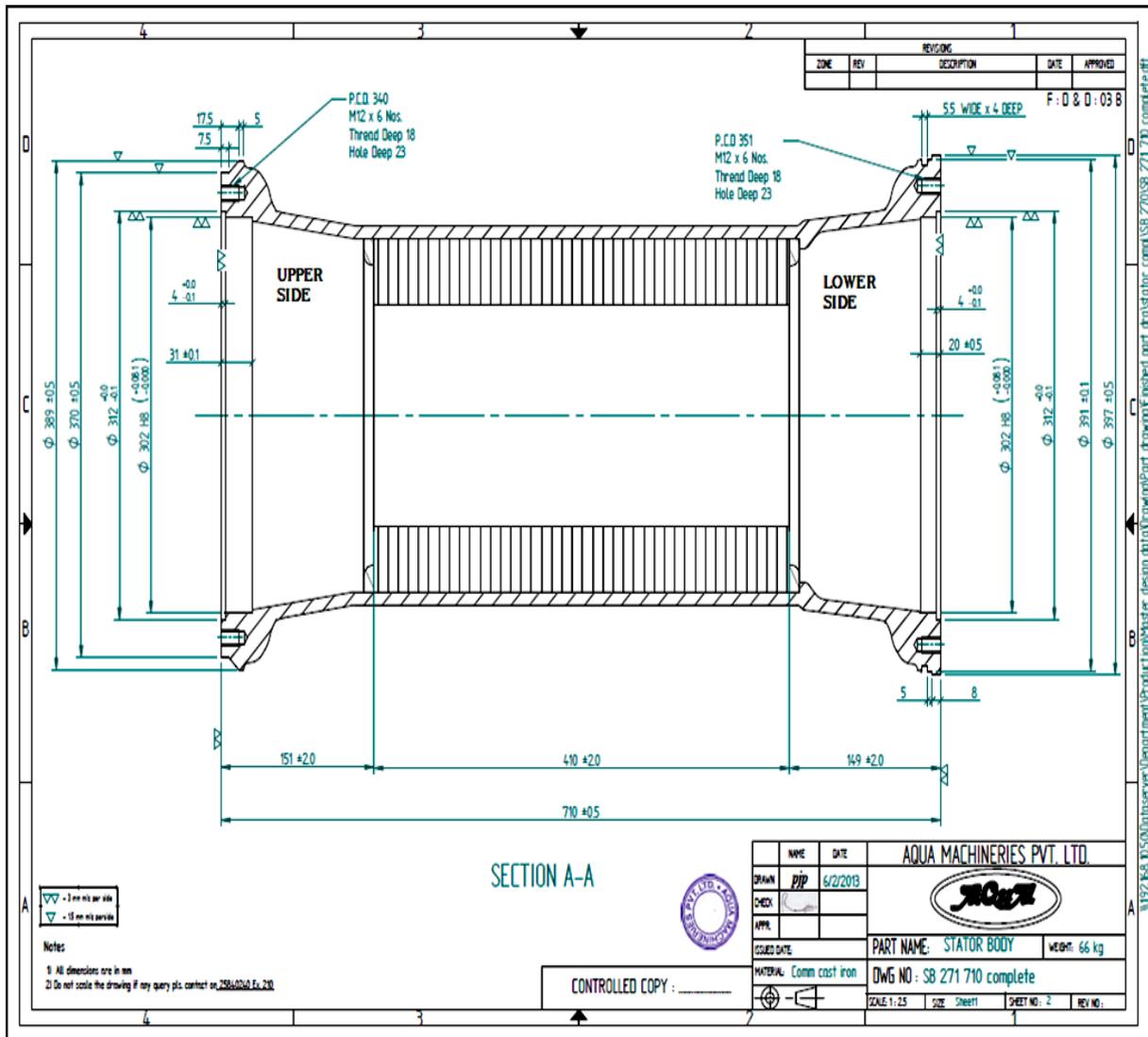


Fig. 2 Design of Body M-270

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RESULT

The experiments have been performed over the M-340 and M-508 body. The results are as follows.
Results for M-208

Table 1 Results for M-208

| Exp No | Thickness of Resin | Filling Time |
|--------|--------------------|--------------|
| 1 | 0.62 | 3 |
| 2 | 0.60 | 3 |
| 3 | 0.53 | 2 |
| 4 | 0.60 | 3 |
| 5 | 0.58 | 3 |
| 6 | 0.65 | 2 |
| 7 | 0.56 | 4 |
| 8 | 0.72 | 3 |
| 9 | 0.61 | 2 |
| 10 | 0.63 | 3 |
| 11 | 0.50 | 3 |
| 12 | 0.71 | 2 |
| 13 | 0.70 | 3 |
| 14 | 0.61 | 3 |
| 15 | 0.59 | 2 |
| 16 | 0.50 | 3 |
| 17 | 0.71 | 3 |
| 18 | 0.65 | 2 |

Results for M-340

Table 2 Results for M-340

| Exp no | Thickness of Resin | Filling Time |
|--------|--------------------|--------------|
| 1 | 0.65 | 9 |
| 2 | 0.64 | 9 |
| 3 | 0.57 | 7 |
| 4 | 0.63 | 9 |
| 5 | 0.61 | 9 |
| 6 | 0.66 | 7 |
| 7 | 0.59 | 10 |
| 8 | 0.75 | 9 |
| 9 | 0.63 | 7 |
| 10 | 0.66 | 9 |
| 11 | 0.54 | 9 |
| 12 | 0.75 | 7 |
| 13 | 0.73 | 9 |
| 14 | 0.64 | 9 |
| 15 | 0.61 | 7 |
| 16 | 0.54 | 9 |
| 17 | 0.75 | 9 |
| 18 | 0.69 | 7 |

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The project F-value of 6.29 suggests project is important. There is simply 2.70% casual who an F-value its big could follow owing to sound. "Values of " "Prob > F"" below 0.0500 require perfect positions are important. Its instance E, H is major model terms. Values greater than 0.1000 specify the project positions no major. It's various unimportant projects positions (not including individual obligatory to provision grading), projects decrease might progress structure.

Table 3 R-Squared Table

| | | | |
|-----------|-------|----------------|--------|
| Std. Dev. | 0.031 | R-Squared | 0.9379 |
| Mean | 0.61 | Adj R-Squared | 0.7887 |
| C.V. % | 5.06 | Pred R-Squared | 0.1947 |
| PRESS | 0.063 | Adeq Precision | 8.186 |

III. CONCLUSION

Conclusions This study explores metabolic responses of baby spinach tissue that follows the application of VI with commonly used substances for impregnation of fruit and vegetables. The following are the main results:

- i. Introducing different substances into baby spinach leaves by vacuum impregnation provoked different effects on the short term gross metabolic activity measured with isothermal calorimetry. Sucrose and calcium lactate provoked rapid increases in the gross metabolic activity of the leaves while no change was detected after impregnation of citric or ascorbic acid.
- ii. Different changes in sugar composition (sucrose, glucose and fructose) were detected, depending on the impregnated substance. The total sugar concentrations at each time point is likely the result of the balance between metabolization of the sugars and mobilization of starch, the concentration of which decreases in the impregnated leaves during 4 days of cold storage in darkness.
- iii. The detected effects of the impregnation with different substances are likely to be a consequence of their metabolization by the cells in the tissue.

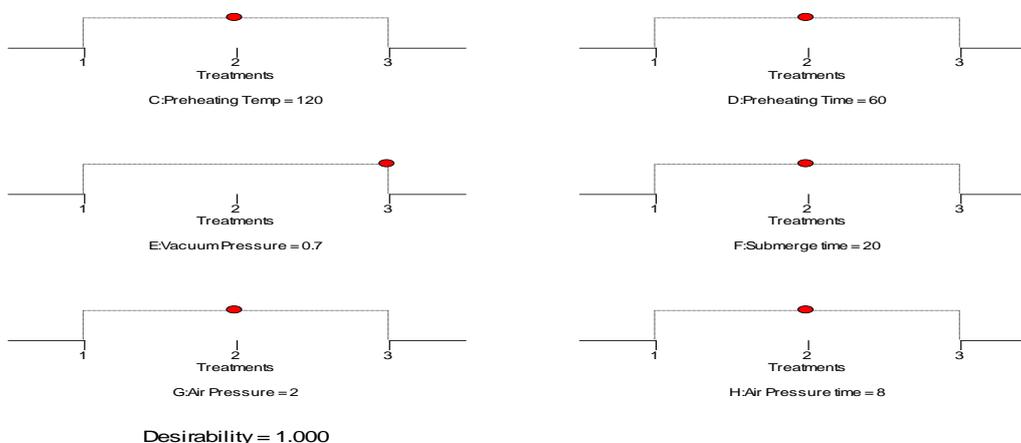


Fig 4 Optimised Parameter for M-270

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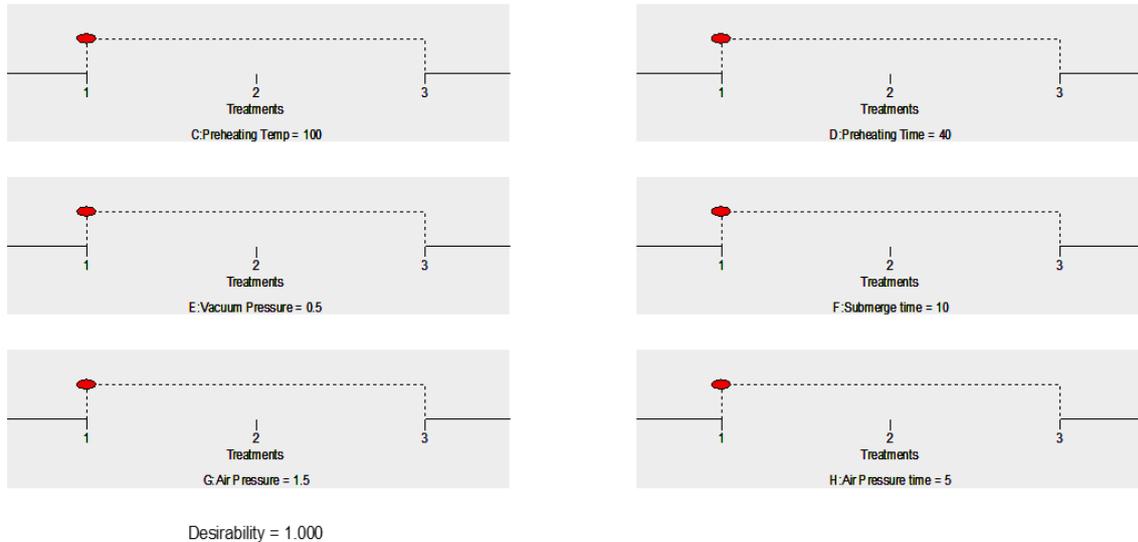


Fig 5.2 Optimised Parameter for M-340

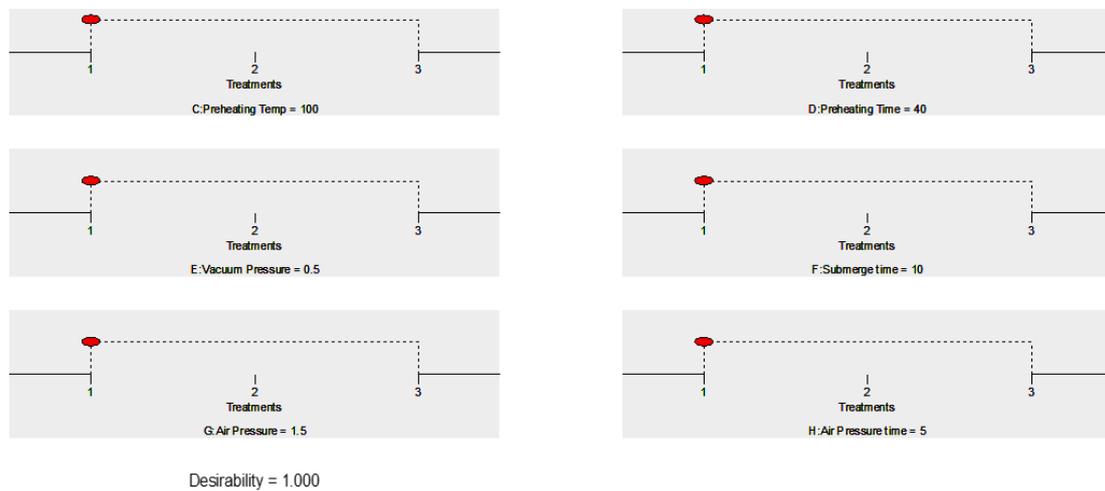


Fig. 5 Optimised Parameter for M-508

From the analysis and experimentation, we came to know about the possible set of the parameters for the Vacuum Pressurised Impregnation Plant to work efficiently.

We can see the set of optimum input parameters in above figures.

With this set of parameters we can assure the thickness of the resin which has been impregnated to the winding is minimum which is around 0.6 mm and the filling time also should be minimum for the each body.

By using these set of parameters we can assure the maximum use of the resources which is available as well as minimum waste of the resin material.

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IV. FUTURE WORK

The work described in this thesis sheds new light on the metabolic consequences of VI. However, a number of important areas need to be studied in the future.

- Detailed studies should be carried out on the effects of impregnation on the shelf life of baby spinach leaves. These could include microbiological studies and investigations on the changes in the quality of packed spinach leaves, for example, electrolyte leakage as an indicator of membrane deterioration, colour and chlorophyll changes. The overall quality of the impregnated leaves should be investigated by sensory evaluation studies.
- Further investigation is needed on changes in other important nutritional factors such as ascorbic acid. The use of redox markers may provide information on the change in ascorbate, and/or the ascorbate-to-dehydroascorbate ratio. Metabolic profiling (metabolomics) of impregnated tissues should be carried out in order to obtain a general overview of the metabolic pathways that may be affected by VI.
- Studies on the dynamics of the impregnation process in the tissue could be performed using X-ray microtomography. In situ visualization of the impregnation of plant tissue by a solution in real time may be possible with 4D microCT technology.

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