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Process control in latex operations

In process control in latex operations it is important to have minimal control on temperatures, air flow rate, dwell time, relative humidity and line speed

In the last issue of *Rubber Asia*, I outlined material control as the initial section of a quality/process control overview.

Material control covered minimal control on raw materials; latex or compounded latex, dispersions, solutions and slurries; and latex compounding. A latex dipping operation that makes proper use of these minimal controls should be able to have the necessary latex compound, coagulant solution, and powder slurry ready for transfer to the dip line tanks.

Each latex dipping operation should also have proper control in the process. In the process control it is important to have minimal control on temperatures, airflow rate, dwell time relative humidity and line speed.

Process control

- The design of the dip line is based on a process provided to the dip line fabricator and a production rate established by the purchaser.

For example:

- Assume a production rate of 25,00,000 gloves per month at 95% quality is established by the purchaser.
- With a 5-day, 24 hours/day work week, this converts to 5064 gloves/hour, or 84 gloves/minute.
- With a double chain arrangement and dipping mandrels spaced at 15 cm, this converts to a line speed of 6.3 metres/minute.
- If the process requires 20 minutes to dry the gloves after leaching, the drying oven would be 126 metres in length.
- Each segment of the process is put through a similar calculation to establish what space is required for that segment of the process.

- The process parameters of temperature, air flow rate, and dwell time go hand in hand with line speed.

Temperature:

- Each tank and each oven must be held at the temperature established by the process. How much variation that can be permitted is also established by the process.
- Controls must be placed on the heat source or the cooling source to ensure temperatures are maintained.
- With today's technology, these temperatures can be automatically controlled, monitored and recorded. However, it is essential that the machine operator checks these temperatures on a regular schedule to ensure that the technology is operating correctly.
- If the latex temperature becomes too high, dipping will be affected. If leach temperatures become too low, protein content and chemical residues will increase. If oven temperatures become too low, drying or curing will be incomplete.

Air flow rate:

- Air flow rate is at least as important as temperature in drying and curing. Increased flow across the surface of the latex film will dry it more quickly and the film will get up to temperature more quickly.
- As a "rule of thumb", air flow rate across the surface of the latex film should be no less than 75 metres/minute..

Relative humidity

- The critical place for concern about high relative humidity ▸

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conditions is in the drying ovens. Ovens should have a provision for the introduction of fresh make-up air to ensure that the relative humidity within the oven does not get so high that drying is inhibited. Air must be sufficiently dry so that it can remove water from the latex film.

- Today's technology provides automatic equipment to read relative humidity and to use that information to automatically channel fresh air into the oven circulation system. Periodic checks should be made to ensure the equipment is operating properly.

Dwell time

- Dwell time is a function of equipment design and line speed. Therefore, only small variations of dwell time are possible. If line speed is varied by adjustments to improve drying, vulcanization, or leaching, then dwell time will be affected.
- If the line speed is producing proper drying, curing, and leaching, and the thickness is more or less than required, coagulant concentration or latex % total solids should be used for thickness control. Changing line speed to increase or decrease dwell time will adversely affect other critical process times.

Line speed

- Line speed is tied to equipment design. There are definite limits, to which line speed can be increased beyond the original design parameters.
- An increase in line speed will reduce the time in other critical operations. If drying time is shortened to such an extent that gloves have a high moisture content when stripped, quality will suffer.
- Other process parameters can be adjusted to allow increases or decreases in line speed. However, these adjustments cannot be allowed to adversely affect quality.

Tank agitation and flow direction

- Latex tanks should have agitation for several reasons:
  - To prevent compounding ingredients from settling to the bottom.
  - To keep the surface of the latex moving to prevent formation of surface "skin".
  - To reduce the relative movement of mandrels passing through the tank and the latex.
  - To move the latex through a screen to eliminate coagulum and foreign matter.
  - To equalise latex temperature.

The flow should be in the direction of dipping mandrel movement and the surface speed of the latex should be approximately the same as the line speed.

- Coagulant tanks should also have agitation to maintain intermixing of all ingredients particularly when powder is present in the coagulant.
  - Agitation also equalises the temperature within the tank.
  - As with the latex tanks, the flow direction in the coagulant tank should be the same as dipping mandrel travel.
- Slurry tanks should have agitation to keep the powder from settling to the bottom. Flow direction is not important.
- Leach tanks should have agitation to improve the leaching. Turbulent flow increases extraction efficiency. The direction of water flow must be in the opposite direction to the dipping mandrel travel. Fresh water should be fed into the exit end of the tank with the overflow at the entrance end. This means that the dipping mandrels encounter fresher and fresher water as they pass through the leach tank. ■

(To be continued)