

## Removing toxic elements from friction material formula

The research department at Frenos Sauleda S.A. is trying to find an alternative formulation for one of his produced materials. There are two components in its formula, toluene and sepiolite, which are yet forbidden in some countries and could be forbidden shortly also in Spain.

Toluene is a volatile organic compound used commonly as a solvent. It may have local as well as systemic harmful effects. It may cause irritation of the eyes, respiratory tract, and skin. Other symptoms include headache, dizziness, fatigue, muscular weakness, collapse, and coma.

Sepiolite is an abundant fibrous clay mineral with modest to good adsorption properties and extensive industrial process applications. The applications are based on following three types of properties: adsorptive, rheological, and catalytic properties. The typical industrial applications are decoloring agents, absorbent granules, cat litter, carriers for insecticides and herbicides, dispersants, rubber and plastic industries, asbestos substitution and cosmetics. Sepiolite is produced commercially almost exclusively in Spain. It is currently believed that fibrous minerals are potentially active to induce mesothelioma. Their carcinogenic effects are thought to be related to fiber size and shape, rather than chemical composition. They appear to behave in biological systems in much the same way as the asbestos minerals.

The product to develop is formed by thread and paste. Toluene and sepiolite are the components of the paste to be replaced. The thread-paste ratio must be maintained.

The union of the thread and the paste is done through an extrusion process. The new components and proportions of the formula must produce a paste that behaves similarly to the current one in terms of wet and flowing, to keep the extrusion machine working properly.

Toluene reduces the viscosity of the paste, it keeps the material flowing, we cannot. We need to replace it with a liquid resin of similar viscosity. We know the viscosity of the raw materials, but we don't have a viscometer to check the viscosity of the mix.

The control variables in the process are the following:

- Spindle speed and thread entry speed (they depend on the machine voltage selected)
- Head temperature (melting temperature)
- Product weight per meter
- Formulation

We must get a compromise between all the variables. Low speed reduces production, high temperature affects machine performance and lifespan.

We need to keep also the performance properties of the final product. The control properties of the product are coefficient of friction, wear and density.

We would appreciate your directions on how to set up and organize our essays in the most optimal way.