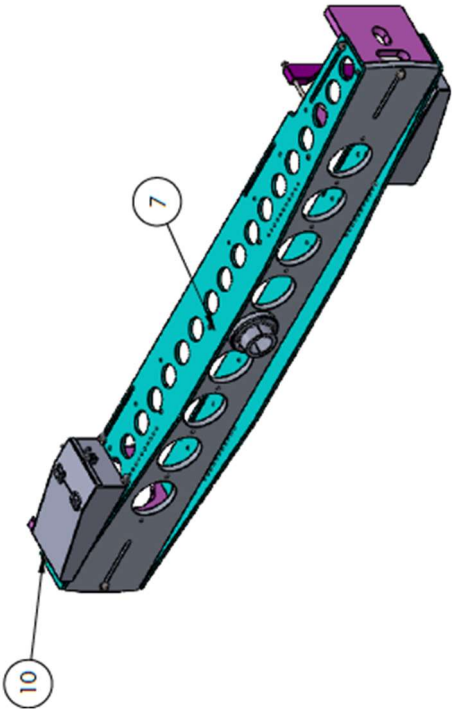
IMCEPO

Development new potting technology for gas separation hollow fiber membranes

THE CONTEXT

Parker is a manufacturer of PPO-based hollow fiber membrane products which are used for air separation applications in aerospace and industrial areas. The objective of the project is to develop a new potting technology for one of our largest products to allow expanding its operating conditions. A new epoxy adhesive formulation and potting process needs to be found that allows the manufacturing of hollow fiber gas separation modules with a housing of at least 150 mm diameter. The final tube sheet needs to have sufficient mechanical strength and glass transition temperature to allow operation at 65°C and 13 barg. The fibers need to be potted using a centrifuge to prevent wicking effects which typically cause fiber breakages upon pressurization of the module.



DESIGN NEW POTTING FIXTURE AND MOUNTED IN CENTRIFUGE.

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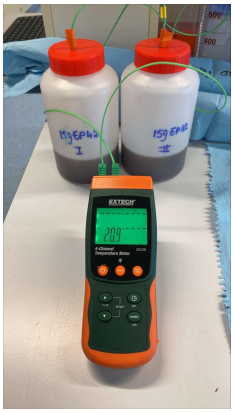
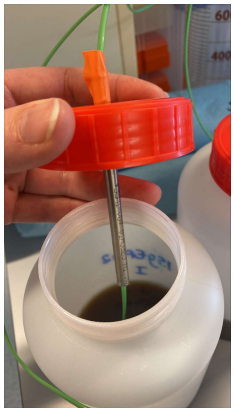
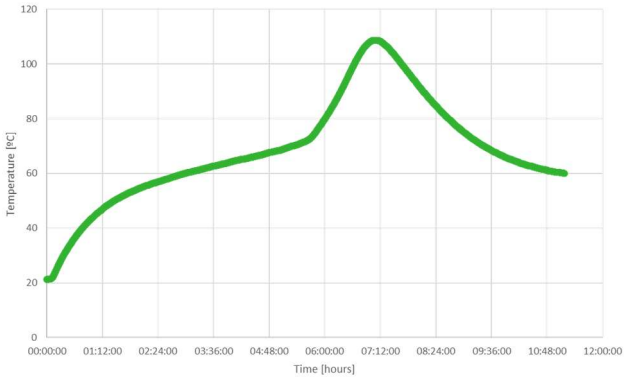
THE CHALLENGE

Typically, epoxy adhesive mixtures with high Tg react strongly exothermic when a certain temperature is achieved (so-called kick-off). The exotherm becomes larger when larger amounts of adhesive mixture are used. This exotherm needs to be properly controlled to prevent defects in the tube sheet.

The main challenge of this work is to select the right combination of adhesive components that fulfill the technical requirements of the final tube sheet, can be used with products up to 150 mm OD (specific mass), can be potted using a centrifuge, does not kick-off at room temperature but does not overheat due to the exotherm and a curing schedule that allows large-scale manufacturing. A cure schedule needs to be defined with low peak exotherm that results in an epoxy fully cured all through and fully stress relieved.

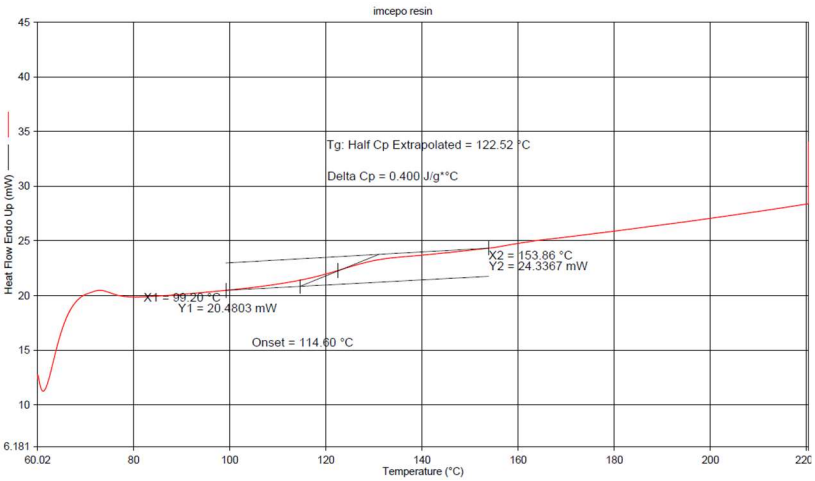






SETUP TO INVESTIGATE REACTION KINETICS & EXOTHERM

MOULD, DOG BONE SAMPLE AND INSTRON TENSILE TESTER



DSC AND THERMOGRAM OF ONE OF THE RESINS INVESTIGATED.

RESULTS & CONCLUSION

Various suppliers were approached for suitable epoxy adhesive systems based on the defined specification, but only a few responded and could offer a suitable system. Especially the high Tg required made the selection difficult for suppliers (without having to develop something new). Despite these difficulties, the IMCEPO project did result in a selection of systems that based on their datasheet fulfil most of the requirements. The systems that were obtained were screened for their reactivity (exotherm), thermal and mechanical properties. A method was developed to analyze the reaction kinetics using DSC. Furthermore, a silicone-based mould was developed to prepare sample bars for testing the mechanical properties of the various epoxies using an Instron tensile tester.

Based on the results, the most suitable epoxy system was selected for further trials with hollow fiber membranes. A potting fixture was designed and built and mounted to the existing centrifuge to allow potting first 6”scale prototypes with the selected epoxy adhesive system. The module consisted of 3D-printed potting caps, that were glued to a straight thin-walled stainless steel tube.

TECHNIQUES USED

In the IMCEPO project the various samples were characterized by techniques available at the INNOMEM OITB, EMI Twente:

- Instron tensile tester (3-point bending test, mechanical properties)
- DSC (reaction kinetics and Tg)

Furthermore, several other facilities of the OITB were used:

- Potting centrifuge.
- 3D-printers
- Temperature sensors.
- Band saw and cutting tool.

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