

# Testing Vapor Pressure of Polyol and Blowing Agents

## *Problem*

Foam plastic made of polyurethane is used in a variety of industries, particularly for insulation purposes. In a pre-stage of producing foam plastic, special polyol blends are mixed with smaller quantities of a blowing agent, usually pentane, to create soft or solid foam.

For production it is essential to determine the vapor pressure of polyol mixed with blowing agents at different temperatures, to determine the **quality of the foam** and the **foaming kinetics**. Once mixed with the isocyanate, the polyol/blowing agent mixtures can easily expand to 35 times the volume they previously held. To know the vapor pressure of this mixture is vital for the correct dimensioning of the storage tanks, of the processing facilities, of the mixers and of the batch containers.

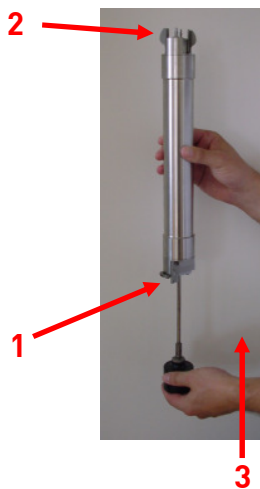
Vapor pressure tests of polyol/blowing agent mixtures is a challenging thing to do. First those samples are viscous and sticky and secondly the analyzer has to be cleaned thoroughly after measurements. Also the tendency of sample separation has to be controlled, as the results of the vapor pressure tests have to be taken from homogenized samples.

## *Solution*

### A. Method

The GRABNER INSTRUMENTS vapor pressure tester MINIVAP VPXpert and a Floating Piston Cylinder (FPC) is used to test polyurethane blends.

1. The polyol blend is mixed with the proper blowing agent (e.g. n-pentane or cyclopentane)
2. The sample is mixed vigorously to form a homogenous mixture
3. Filling: The sample is then poured into the FPC and the FPC is closed, leaving one screw open to remove the air from the FPC.
4. Similar to removing air from syringes, the FPC is held vertically and contracted, until some sample shows on the front valves of the FPC. Then second valve of the FPC is then sealed.

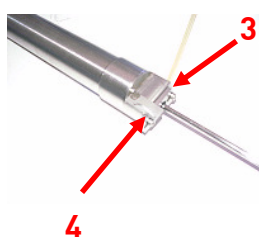
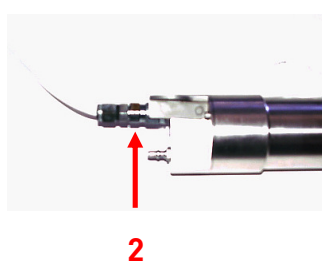


#### **Filling of the FPC:**

- 1) Open the bottom valve
- 2) Leave the front valves open and hold the FPC vertically
- 3) Make sure the stirrer is locked and push upwards to remove the air, until sample shows on the valves
- 4) Close the front valves

**B. Measurement**

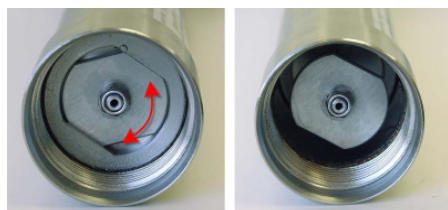
1. The FPC is attached to the MINIVAP VPXpert analyzer via a quick connector.
2. At the piston side of the FPC, 3bar (air-)pressure is attached, for a constant pressure of 3 bar. This guarantees, that the highly viscous sample is filled correctly into the measuring cell.
3. Select the Grabner Method ASTM D6377, the method to test vapor pressure of crude oils, and test at 37,8°C at a V/L ratio of 4:1. The ASTM D6377 program guarantees that the sample is filled with constant velocity and is also homogenized prior to measurement.
4. Press RUN
5. During temperature regulation use the mechanical stirrer at the FPC to guarantee that the sample stays homogenous. Once rinsing starts, end stirring.



**Attaching the FPC to analyzer and feedline**

- 1) Check that all valves are closed
- 2) Attach the filling tube to the FPC and connect it with the instrument
- 3) Connect the feedline to the FPC
- 4) Open the bottom valve to get pressure in the FPC
- 5) Open the front valve leading to the analyzer

**ATTENTION: If the FPC is not connected with the analyzer, sample will be spilled at pressure of 3 bar!**



**Stirring**

**C. Results**

Results of the method ASTM D6377 for total vapor pressure (P<sub>tot</sub>) are shown below. The P<sub>tot</sub> is the combined vapor pressure of the partial pressure of dissolved air in the sample and the vapor pressure of the liquid.

**Vapor Pressure of polyurethane blend mixed with n-Pentane ( $\sigma \sim 1$  kPa)**

Sample Name	Filling T	Meas. T	V/L ratio	P <sub>tot</sub>	Units
Blend + n-Pentane	20.0	37.8	4.0	103.2	[kPa]
Blend + n-Pentane	20.0	37.8	4.0	102.3	[kPa]
Blend + n-Pentane	20.0	37.8	4.0	100.5	[kPa]
Blend + n-Pentane	20.0	37.8	4.0	100.9	[kPa]
Blend + n-Pentane	20.0	37.8	4.0	101.5	[kPa]
Blend + n-Pentane	20.0	37.8	4.0	102.5	[kPa]

## Vapor Pressure of polyurethane blend mixed with Cyclopentane ( $\sigma \sim 0.2$ kPa)

Sample Name	Filling T	Meas. T	V/L ratio	Ptot	Units
Blend + Cyclopentane	20.0	37.8	4.0	67.5	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.3	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.1	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.4	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.6	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.6	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.7	[kPa]
Blend + Cyclopentane	20.0	37.8	4.0	67.4	[kPa]

A small drift in vapor pressure readings could be experienced, if no stirring was performed, which shows the tendency of the mixture to separate. Proper stirring guarantees that the sample is homogenized continuously and that the vapor pressure readings are repeatable.

After each of the two test cycle, two acetone rinsings were performed to remove sample residue from the MINIVAP VPXpert.

## Conclusion

The repeatable results and the excellent usability make the MINIVAP VPXpert vapor pressure analyzer and the FPC a highly recommendable package for the accurate determination of vapor pressure of foam plastic, polyol and blowing agents.