Vane rotors for pressure cells

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For rheological measurements at elevated pressure and temperature, various pressure cells are available for the Thermo Scientific™ HAAKE™ MARS™ Rheometers[1] and the special pressure cell setup of the Thermo Scientific HAAKE Viscotester™ iQ Rheometer.[2] When testing inhomogenous samples or fluids containing large suspended particles, most pressure cells can be equipped with different vane rotors.

Each rotor consists of 4 blades symmetrically arranged around a shaft, which is equipped with two halves of an upper and a lower sapphire bearing (metal pin and sapphire ring). The two counterparts of the bearings are located inside the pressure cells sample reservoir and sealing cover. With these two bearings the rotors are precisely centered inside the pressure cell.

The vane rotors differ in the size of the blades. The biggest vane rotor FL25 93-PC has a diameter of 25 mm and a blade height of 93 mm. This rotor is particularly suitable for measurements on low viscous samples.

For measurements on samples with higher viscosities vane rotors with a blade height of 8.8 mm are recommended. For choosing a suitable rotor, the maximum diameter of the suspended particles inside the sample has to be taken into account. As a rule of thumb, the gap between the rotor blades and the inner wall of the pressure cell should be at least 5 times larger than the biggest suspended particles (or 10 times as recommended in DIN EN ISO 3219-2 “Rheology – Part 2: General principles of rotational and oscillatory rheometry (ISO 3219-2:2021). The inner diameters of the different pressure cell models and the gaps between rotor blades and inner walls are shown in Table 1.

Figure 1: Vane rotors with a blade height of 8.8 mm with different diameters of 25 mm (upper left) and 30 mm (upper right), vane rotor with a blade height of 8.8 mm and a diameter of 36 mm (lower left), vane rotor with a blade height of 93 mm and a diameter of 25 mm (lower right).

The standard vane rotors are made of the following materials: stainless steel 1.4301 (blades), stainless steel 1.4305 (shaft), Stellit (bearing pins). The blades and the shaft of the Hastelloy vane rotors are made from Hastelloy B3.

A typical application for pressure cells with vane rotors is the viscosity measurements of crude oil under elevated temperature and pressure conditions in order to simulate the flow behavior in an underground oil reservoir and during pipeline transport.

Figure 2: HAAKE MARS iQ Rheometer with pressure cell.

Table 1: Inner diameters and gaps of different pressure cell / rotor combinations

Pressure cell model	Inner diameter sample compartment in mm	Gap between rotor blade (25 mm diameter) and inner wall of pressure cell in mm	Gap between rotor blade (30 mm diameter) and inner wall of pressure cell in mm	Gap between rotor blade (36 mm diameter) and inner wall of pressure cell in mm
D100/200	40	7.5	5	2
D400/300	39	7	4.5	1.5
D600/250	35	5	2.5	-
D75/300 Ha	40	7.5	5	2
D170/300 Ha	40	7.5	5	2

Ordering information

Product	Available for	Order no.
Vane rotor FL25 8.8-PC (D=25 mm, H=8.8 mm, A=5.87x10^4 Pa/Nm*):		
Stainless steel version	D100/200, D400/300, D600/250	222-1628
Hastelloy version	D75/300 Ha, D170/300 Ha	222-2334
Vane rotor FL30 8.8-PC (D=30 mm, H=8.8 mm, A=3.74x10^4 Pa/Nm*):		
Stainless steel version	D100/200, D400/300, D600/250	222-1629
Hastelloy version	D75/300 Ha, D170/300 Ha	222-2335
Vane rotor FL36 8.8-PC (D=36 mm, H=8.8 mm, A=54.8 Pa/Nm*):		
Stainless steel version	D100/200, D400/300	222-1630
Hastelloy version	D75/300 Ha, D170/300 Ha	222-2336
Vane rotor FL25 93-PC (D=25 mm, H=93 mm, A=1.0x10^4 Pa/Nm*):		
Stainless steel version	D100/200, D400/300, D600/250	222-1631
Hastelloy version	D75/300 Ha, D170/300 Ha	222-2337

* The A factors given above are based on the equations for calculating the stress from the torque for a vane geometry in a large diameter container (i.e. not in small diameter cylinder) and therefore are not exactly correct. It is NOT possible to calculate a M factor since the shear rate is NOT defined for a vane geometry, it recommended to use M=1.0

References

1. C. Küchenmeister-Lehrheuer, F. Meyer, Pressure cell models for the HAAKE MARS and HAAKE Viscotester iQ Rheometers, Thermo Fisher Scientific Product information P075
2. C. Küchenmeister-ehrheuer, K. Oldörp, HAAKE Viscotester iQ – Portable rheometer configuration for measurements at higher pressures, Thermo Fisher Scientific Product information P054

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