Composite – Hybrid Separating Cans for Wet Rotor Pumps

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***Abstract*— This publication addresses the development and successful serial application of hybrid separating cans made of fiber-reinforced composite material to save electrical energy in the operation of wet rotor pumps. In contrast to metallic designs, hybrid separating cans made of fiber-reinforced composites can be used to produce energy-efficient pumps that outperform conventional pumps in terms of reliability and low noise. Separating cans manufactured using filament winding technology offer to run a high mechanical load at low wall thickness. At the same time, in contrast to metallic designs, the fiber composite remains almost completely free of eddy currents and thus enables a significant increase in pump efficiency.**

Keywords— wet rotor pump , canned motor , eddy current , filament winding technology , fibre-reinforced composite , hybrid separating can , fresh water pump , circulator pump , reluctance motor , asynchronous motor , shaded pole motor

I. Introduction

Efforts are being made worldwide to reduce primary energy consumption. A large amount of energy consumption is caused by pumps, and a significant amount of energy is used to circulate water in heating systems such as radiators, convectors, skirting heating, underfloor heating, boiler charging, solar stations, water circulation in heating or air conditioning systems and similar applications. Due to the very long operation time, there is an enormous energy saving potential for these applications [1]. Since in this area mainly so-called wet rotor pumps are used, this paper focuses on this type of pump.

II. Canned motor

Benjamin Graemiger, who applied for a patent in 1914, invented the canned motor, also called wet rotor motor or glandless pump. Wet rotor pumps are pump units (pump plus drive) whose rotating parts, including the rotor of the driving electric motor, rotate in the liquid pumped medium, which can also be used for cooling and bearing. Prerequisite for this is a separating can in the gap between rotor and stator. Therefore, such drives do not require a shaft seal and are referred to as glandless pumps. Canned motors or glandless pumps are manufactured according to the principle of the asynchronous motor (often shaded-pole motor) or the synchronous motor. Canned motors as synchronous motors are made as brushless DC-motors (abbreviated BLDC- or BL-motor as well as electronically commutated motor, in short EC-motor) with excitation by permanent magnet technology or based on the principle of reluctance motors. These drives are used, for example, in building for fresh water and circulation pumps in heating systems, as lye pumps (washing machines, dishwashers), but also as prefeeding pumps.

The great advantage of the absence of a seal as well as the hermetic separation to the pumped medium also led to applications as a pump for chemicals and food products. Multi-turn actuators in vacuum are also related.

III. Separating Can

In the canned motor, a metallic separating can seals the stator against the rotor surrounded by the pumped medium. The disadvantage, however, is the significantly lower efficiency compared to other pump systems. Due to the metallic separating can, the radial gap between stator and rotor is increased and significant induction losses are caused by the conductivity of the metallic material. Due to their very good insulation performance combined with very high mechanical properties, FWH - separating cans (FilaWin - Hybrid - separating cans) made of fibre-reinforced plastic (FRP) are an excellent alternative as separating can material and can improve the efficiency by up to 30% compared to metallic cans.

In all applications, the separating can is a central component of the pump and must meet high requirements in wet rotor pumps. The separating can is exposed to high pressures and temperatures at the same time, is exposed to pressure and temperature fluctuations and has to be highly resistant to chemicals. Depending on the application, drinking water must also be approved. Failures or leaks in operation can lead to incalculable consequences.

IV. Hybrid Separating Can

Basically, the FWH separating can consists of a fluid-carrying inner layer (liner) and a reinforcement produced by the filament winding process. This design fulfils the high requirements of wet rotor pumps. Due to the continuous carbon fibre running in the circumferential direction in combination with a media-tight inner layer (liner), there are special properties which cannot be achieved with other designs.

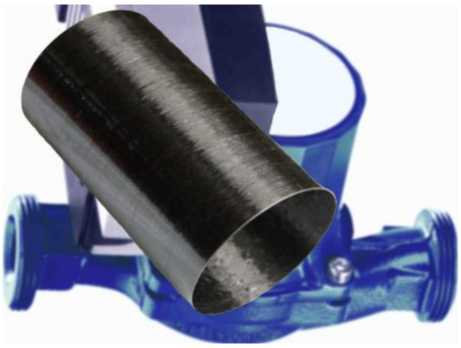

Fig. 1: FilaWin® - separating can made of CFRP.

The FilaWin® technology developed by CirComp offers a very precise and repeatable manufacturing process, enables the production of patented components with low tolerances and high quality and also offers a very good price-performance ratio. The demand for components manufactured in this technology is therefore very high. The continuous, stretched and well aligned carbon fibres in circumferential direction (Fig. 2) allow high strengths, rigidity and the prevention of creep at high temperatures in the application. In addition, this results in an ideal thermal expansion coefficient for the application. Due to these properties, the sealing function between the hybrid separating can and the stationary O-ring seal of the pump housing is ensured over the lifetime of the pump. The requirements for chemical resistance and diffusion tightness without creep tendency and microcracking can only be met by the hybrid design of the described fibre composite reinforcement in combination with a thermoplastic liner, for example made of polyphenylene sulfide (PPS). The special properties of the FWH separating cans (FWH = FilaWin - Hybrid) are listed in Table I.

TABLE I: FWH - SEPARATING CAN PROPERTIES

Manufacturing process	suitable for large series production
Tolerances in inner diameter	minimal
Media-carrying layer	durable
Impermeable to diffusion	yes
Thermal expansion in circumferential direction	~ 0 1/K
Creep under pressure and temperature	no creep
Stiffness in circumferential direction	high
Strength in circumferential direction	high

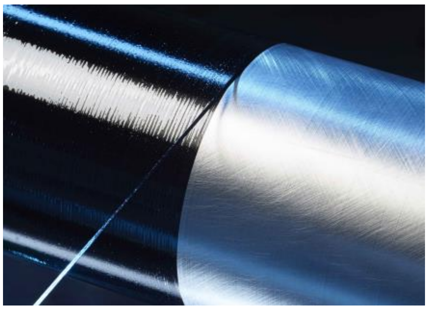

Fig. 2: FilaWin® - CF roving placement

Before the mass production launch of FWH separating cans in hot-water wet rotor pumps in 2004, extensive systematic tests were carried out on plastic separating cans. In addition to static short-term pressure tests, numerous long-term studies were carried out on various types of plastic separating cans.

Fig. 3: Pressure cycling test

These include monolithic, short and long-fiber-reinforced extrusion and injection molding techniques, various types of back-injected inserts, fabric structures and other designs.

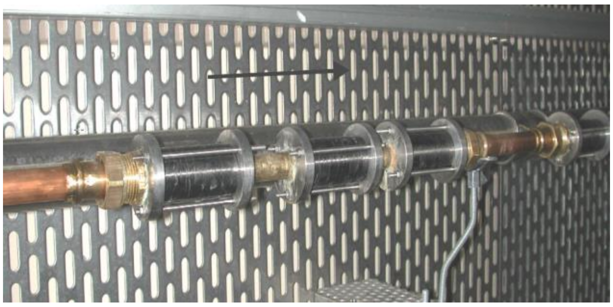

Fig. 4: Temperature cycling test

In fatigue tests (Fig. 3) and fatigue tests at elevated pressures in combination with elevated temperatures (Fig. 4), failures, mainly caused by creep, microcracking, too little stiffness and too high thermal expansion, especially in the area of seals, occurred. Only the FWH separating cans passed the tests without exception.

TABLE II: EXTRACT FROM THE SEPARATING CAN QUALIFICATION

Evaluation	i.a. FMEA
Endurance test / Wear	Field test
Static ageing simulation	i.a. Storage
media resistance	Field test /material tests
Temperature cycling tests	i.a. DVGW W534
pressure cycling test	i.a. DVGW W534

V. CONCLUSION

The hybrid design, which is continuously reinforced with carbon fibre in the circumferential direction, meets the high long-term requirements, which is the reason why this design is used today without exception in all hot-water wet rotor pumps with plastic separation cans of the enhanced performance classes. After a 5-year development and qualification phase followed by field tests, FilaWin® hybrid separating cans are now widely used and have an impressive track record. Such highly efficient circulation pumps with state-of-the-art drive technology are suitable for hot and cold media including drinking water, geothermal and solar thermal systems in heating and cooling circuits and, due to the use of the high-performance FilaWin® hybrid separation cans with the resulting high degree of efficiency in combination with the robust design, lead to significantly lower energy and operating costs.

REFERENCES

[1] J. Schuberth und A. F., „Die EG-Verordnung für die umweltgerechte Gestaltung von Umwälzpumpen,“ Umweltbundesamt, Dessau-Roßlau, 2009.

[2] J. F. Gülich, Kreiselpumpen - Handbuch für Entwicklung, Anlagenplanung und Betrieb, Springer Berlin Heidelberg, 2013.

[3] H. Kech, „Neue energiesparende Pumpenantriebe für Solaranlagen und Heizungstechnik“, 2002.

[4] Bine Informationsdienst, „Stromsparende Pumpen für Heizungen und Solaranlagen, Projektinfo 13/01,“ Fachinformationszentrum Karlsruhe, Gesellschaft für wissenschafltich-technische Information mbH, Eggstein-Leopoldshafen, 2013.

[5] N.N., Pumpenhandbuch