Improve process reliability and reduce emissions with sealless pumps

Several successful applications were implemented at tshis refinery

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The Slovnaft Refinery in Bratislava, Slovakia is a member of the Hungarian MOL Group and one of the largest refineries in central Europe. It processes approximately five MMtpy of crude oil, and a wide range of refined products, petrochemicals and plastics for the European Market. To reduce emissions and improve reliability, we installed canned motor pumps in many of our processes.

Technical philosophy. Our technical philosophy seeks not only permanent improvement in production, performance and maintenance, but also control and reduction of risks for employees and the environment. This philosophy was applied in the extensive new investment projects realized during the past years, in particular Environmental Fuel Project Apollo (EFPA) and the diesel desulfurization unit. These projects increased conversion and significantly improved the environmental parameters of our production processes and products.

Gasoline and diesel production were increased significantly, and sulfur content of all produced diesel was reduced. That ensures diesel fuel compliance with the EU requirement (sulfur content below 10 ppm). Apart from compliance with legislation, we fulfill our own commitment to develop and supply environmentally friendly products and services while decreasing fugitive VOC emissions.

Goal for decreased emissions. European and national environmental laws were tightened over the past decades. Our corporate technical and maintenance management team's strong desire was to reduce emissions and other imperfections concurrently—all while improving the technical parameters and systems' throughput. After considering a number of options, we found that for centrifugal pumps, the demand to decrease emissions could be fulfilled by installing sealless pumps. Being conservative with engineering backgrounds, we originally had some reservations regarding this "unknown technology."

In the early 1990s, we decided to test a canned motor pump in a refinery unit. Up to then we had only a little, but good, experience with a few small canned motor pumps running in the phenol and ethyl benzene processes. Keeping the conventional standby pump installed made it easy for us to test some canned motor pumps in the 3 MMtpy atmospheric vacuum distillation unit.

Our first positive impression of this pump type was the space-saving installation. Canned motor pumps are close coupled, so there is no need for a coupling, coupling protection, separate motor and elongated API base plate (Fig. 1). Nozzle load concerns were reduced since there is no alignment to maintain. This allowed us to keep the original foundation, and no significant pipe or concrete modification were required. It also allowed easy reinstallation of the previous conventional pump, should that become necessary.

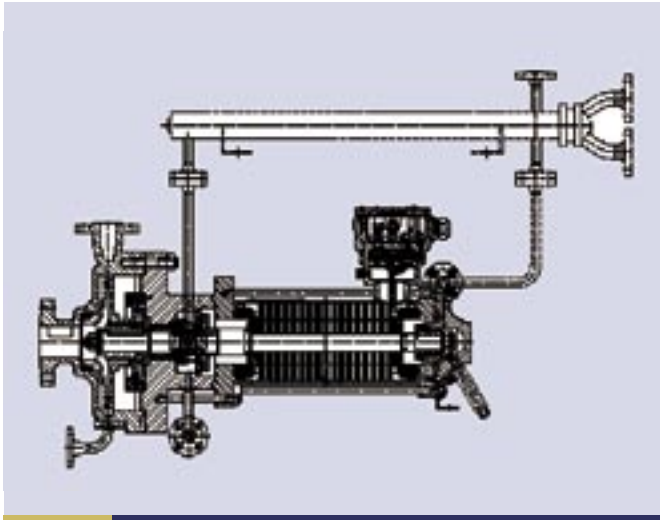

FIG. 1 Canned motor pumps are close coupled, resulting in a more compact installation.

During installation and startup, we recognized further advantages of the new pump models. Thanks to the lack of any mechanical seal, the complete sealing system for a double mechanical seal was avoided. Furthermore, the pumps run far quieter than the conventional pumps they replaced—many below 80 dBA. They were so quiet that our operators had to view the pressure gauge to tell if they were running.

As a result of the excellent experience with the sealless canned motor pumps, we replaced all important atmospheric vacuum distillation unit pump and another 2 MMtpy atmospheric distillation unit with these machines during the following years (Fig. 2).

Mean-time-between-repair. In all our refining process units such as vacuum distillation, FCC, hydrotreating, alkylation and sulfur recovery, equipment selection and repair is determined not only by process capability, but also by safety and environmental considerations as well as mechanical reliability and maintenance cost. The normal refinery process conditions of high temperature, low specific gravity, low lubricity, high vapor pressure,

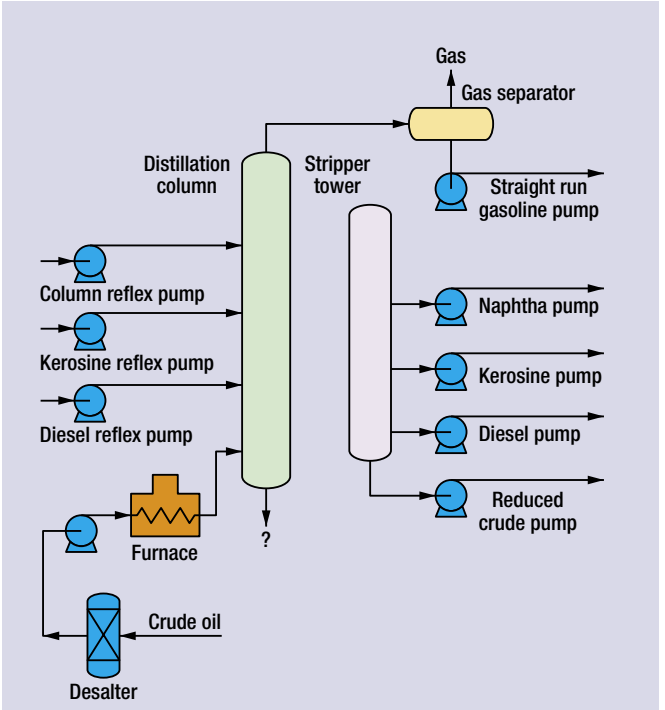

FIG. 2 Several pumps in this distillation unit were replaced with canned motor pumps.

high suction pressures and corrosion all impact maintenance and service of the rotating equipment. Capturing pump failure and repair costs and then statistically analyzing that data, led us to improve our requirements for pump installation and repair. We were intent on improving mean-time-between-repair (MTBR) and plant availability rates.

At our refinery, the basic MTBR was defined by the whole production unit's overhaul cycle, which normally was three years, with the goal being four years of operation to next overhaul. Further, by the time a pump is pulled, repaired and reinstalled, four weeks have often elapsed. That introduces a processing unit to availability risk, which we would rather avoid.

The only pump services we keep running with conventional mechanical sealed pumps are the crude oil feed pumps, the atmospheric column residue pumps and the vacuum column residue pumps. All of those pumps require large kW, higher voltage motors; otherwise they would now be canned motor pumps also. All the remaining vacuum distillate services are handled by sealless canned motor pumps, even with high temperatures up to 350°C (662°F). The canned motor pumps are running up to 320 kW (430 hp) with 400 V.

Additional installations. Thanks to the excellent results we achieved with sealless pumps running in the distillation unit, we decided to go further with canned motor pump installations, of course only where technically possible and economically profitable (Fig. 3). We found that a large number of low-density hydrocarbon applications could be covered by sealless canned motor pumps. We are now pumping liquid methane at the low temperature of –95°C (–139°F). In the same petrochemical unit, sealless pumps are operating with ethylene, pyrolysis gasoline and other products.

FIG. 3 Typical canned motor pump installation.

We are also operating our hydrocracking unit with some canned motor pumps for similar services as in the distillation units. Many LPG tanks are equipped with canned motor pumps, and a pump replacement program is continuing systematically. We are now using them also in the loading/unloading unit of the railway and truck loading station, as well as in specific applications in the polyethylene and polypropylene units, and other petrochemical processes. In one process, we have installed canned motor pumps with 10 stages for high differential head at low temperatures. Gasoline and gasoil blending are also completely equipped with seal less canned motor pumps to reduce emissions of the entire operating unit.

Mechanical seals, antifriction bearings, alignment on high-temperature pumps and nozzle load concerns were all eliminated by switching to canned motor pumps. For each application we carefully reviewed the canned motor pump bearing selection, stator liner material, vapor pressure of the warmer fluid in the motor area and pump configuration (horizontal or vertical). After years of successful operation, we have more than doubled our MTBR on those services to over six years. Repair costs have thus dropped significantly. Processing unit availability is seldom affected by a pump-related issue.

Maintenance and operational history indicate that over 65% of our centrifugal pump repairs were due to mechanical seals and antifriction bearings. We found the two failure modes closely linked; bearing failure would almost always result in seal failure. Likewise, seal failure resulted sometimes in some bearing lubrication contamination, which caused bearing failure. Several times we opened the pumps for repair and often changed bearings and wear parts that were still nearing clearance limits, which added to the cost and often resulted in the pump being out of service longer.

Reliability results with zero emissions. We are operating approximately 200 canned motor pumps in different materials such as carbon, chrome or stainless steels according to the API 685 material classes. Multistage canned motor pumps, which are recommended for higher differential heads thanks to their improved efficiency, are all equipped with a pressure barrel to reduce the number of static gaskets per API specification. As with conventional pumps, all suction pump sides are equipped with level monitoring for dry run and cavitation protection. The canned motors are equipped with thermistors for overload protection, just as we have done in the past with conventional pump motors. Utilizing canned motor pumps has helped us in the past 14 years at our refinery to reduce our maintenance cost, increase unit throughput, reduce emissions, improve the working environment

for our employees and increase processing unit availability.

Applying canned motor pumps has become a standard part of our technical policy in specific cases of difficult or environmentally sensitive services. We also utilize them as an alternative to a pressure-barrier dual-mechanical seal system, if technically possible and economically profitable. For example, we also use the canned motor pumps in MDEA service. Those pumps have a differential head of approximately 400 m (1,312 ft) and are running in nonstop operation without any problems. Further, in LPG with high H_2S content, our canned motor pumps have more than 10 years' trouble-free operation. Many canned motor pumps are installed in many different processes to reduce VOCs. We use them where benzene and benzene-containing products are handled. We have had success with them in the ethylene oxide unit as well.

Gerald Zima is head of Technical Supervision of Maintenance Management Department in Slovnaft Refinery Bratislava. He graduated from Czech Technical University in Prague. He started as a graduate mechanical engineer in the area of the operation, maintenance and repairs of rotation machines especially compressors and turbines then as specialist for machinery maintenance. Later on he was appointed to the manager positions responsible for technical support of engineering, construction, installation, operation and maintenance of machine equipment in Slovnaft Refinery. He has over 25 year experience with problem solving in operation and maintenance of machinery. He has been participating in creation of Refinery technical policy. **HP**

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Pavel König is a petrochemical engineer who has worked in oil refining since 1979. His range of experience covers petroleum refining and chemical facilities (Czech Rep., Syria, Iraq, Egypt). Since 2004, Mr. König has been an application engineer of hermetic canned motor and vaccum pumps on the Czech and Slovak markets for Hermetic-Pumpen, GmbH's Czech Republic branch.

Dieter Lau is a mechanical engineer who has worked in the pump industry since 1995. He has experience in design, sales and product management of canned motor, vaccum and cryogenic pumps. Mr. Lau is product manager for the API 685 line—sealless pumps for refinery and petrochemical—Hermetic-Pumpen, GmbH, Gundelfingen, Germany.