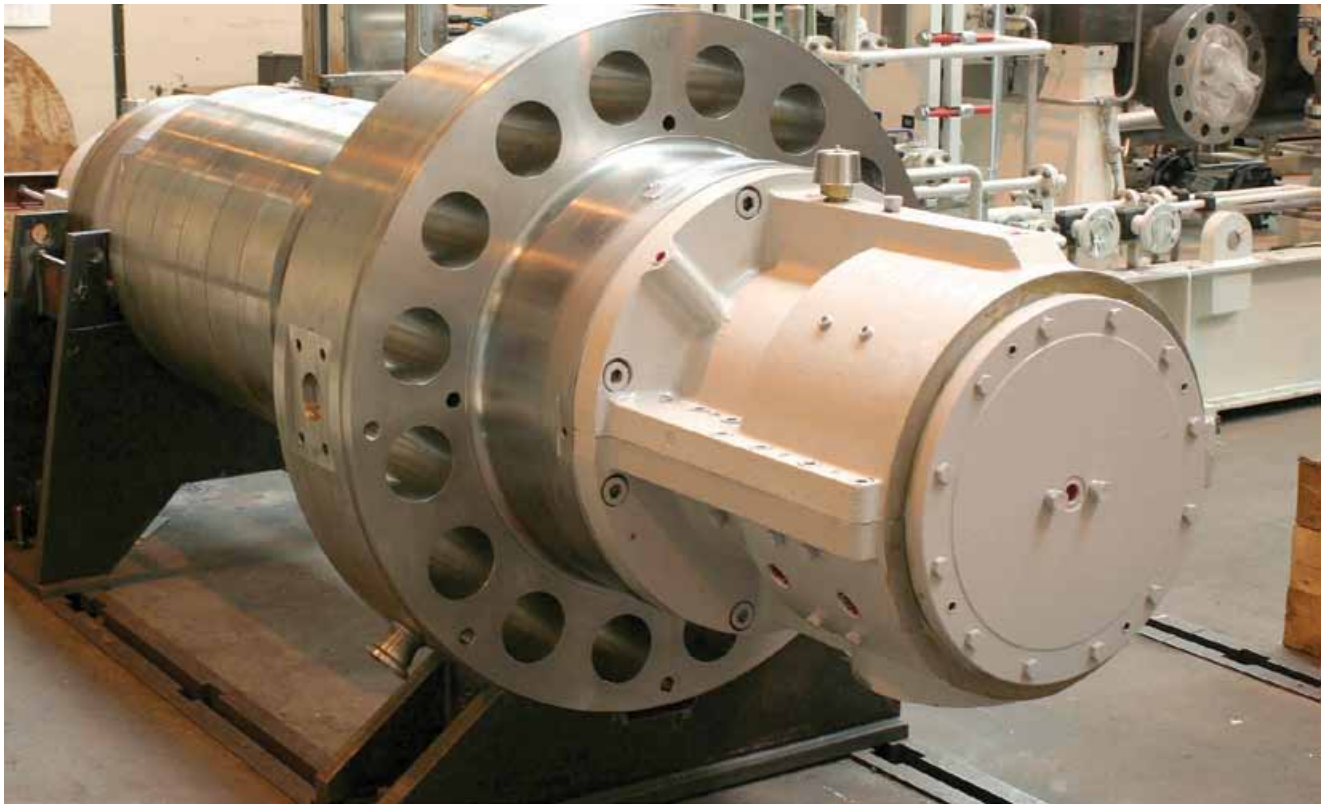
How knowledge assists with maintaining safety and reliability in oil & gas operations

Manjul Saxena, Senior Rotating Equipment Engineer at BP in Surry, United Kingdom, recently spoke with Pump Engineer about his vast experience with pumps and pumping systems, and their applications in the oil and gas industry.

By Deirdre Morgan, Editor



Water Injection Pump Cartridge (courtesy of Sulzer).

PE: Can you tell me about your educational experience and how you came to work for BP?

Manjul: I graduated from Madhav Institute of Technology and Sciences in 1987 with a Bachelor's degree in Mechanical Engineering. From the outset I gained invaluable experience, as I joined Indian Petrochemicals Corporation Ltd. (IPCL) as a management trainee in 1988, and during my five years with IPCL, I was exposed to a broad range of rotating equipment. The site that I was working on had 1500 pieces of rotating equipment, including centrifugal pumps, compressors and turbines, more than 500 different types and sizes of ball bearings and 125 types of lubricants and greases. Evidently, it was a great field opportunity to learn from and like a sponge I absorbed as much information as I could. I subsequently continued on to work in various positions all over the world. I worked for a number of engineering contractors, including Engineers India Limited, Worley and Clough Engineering, and in the year 2000 I moved to Perth to work on the engineering of an LNG (Liquefied Natural Gas) train being constructed in the North West Shelf of Western Australia. In 2004 I prepared the feasibility report for Exxon Mobil's P'nyang gas field. One of the report's recommendations was to consider developing an LNG facility at Port Moresby using gas from the P'nyang and Hides gas field. Subsequently, a two train LNG plant was built in Papua New Guinea. I then moved to Japan in 2008 to develop the concept,

FEED (Front End Engineering Design) and early engineering for an LNG project being constructed near Darwin in the Northern Territory of Australia, before eventually joining BP in 2012. Now based in the UK, my work primarily involves design, engineering and troubleshooting of pumps, compressors, gas turbines and allied rotating machinery.

PE: What duties does your current role involve?

Manjul: As Senior Rotating Equipment Engineer I have a variety of responsibilities, including the design, engineering, installation, commissioning and troubleshooting of rotating equipment, as well as being responsible for identifying, running or participating in strategic improvement projects. For example, I am currently supporting the BP Operations Team with troubleshooting high bearing temperature issues in speed increasing 32,000 kW gearboxes which are driving centrifugal compressors. I also provide support to relevant technical communities, encourage discussions during 'Lunch & Learn' sessions held in the company and attend regional performance review meetings with the key equipment suppliers. My job also demands my participation as a Subject Matter Expert in various technical audits and reviews, such as hazard identification, hazard and operability studies, protection analysis, major accident risk assessment, quantitative risk assessment and root cause failure analysis. I enjoy the variety in my job, as the role provides me with the opportunity to work with a variety of challenging problems in many different projects. One day I could be involved in the technical issues related to high pressure water injection pumps in Azerbaijan, while on another day I could be working on large centrifugal compressor issues in the North Sea, Trinidad and Tobago or Indonesia.

PE: Are there specific aspects of your job that you find challenging or enjoyable?

Manjul: The most challenging aspect of the job is making sure that we are consistently selecting technical solutions that are, first and foremost, safe and reliable, whilst also being cost competitive over the short and long term. This means that one has to be aware of the wide variety of technical solutions that are available in the industry so as to be able to recommend robust options when new projects are designed or new problems are being considered. As a facility operator I need to fully understand the applicable operating conditions for the life of the operating asset when selecting the most suitable rotating equipment for any oil and gas facility. These conditions then need to be communicated to the engineering, procurement and construction (EPC) contractor and the equipment supplier to ensure that the equipment design can be tailored to meet the varied field demands. I have come across cases whereby an incorrect definition of the operating conditions in the purchase specification can lead to poor reliability issues during operation

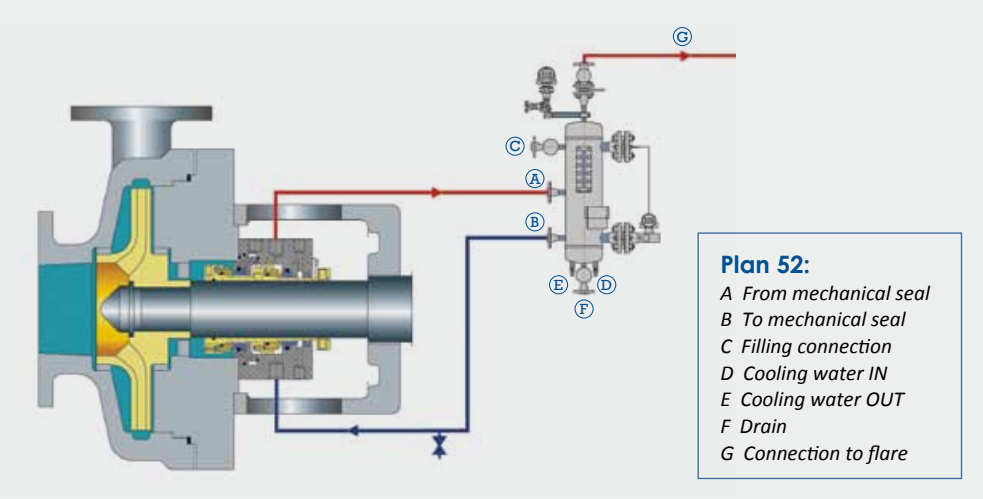
Main oil pump (~100,000 bpd) on test bed (courtesy of Flowserve).

in the field. High equipment reliability is a joint effort between the plant operator, the EPC contractor and the equipment supplier. In addition, developing clear and concise requirements in the data sheets and the specifications is one of the more important aspects of my job. As a senior engineer, I am expected to apply BP's numerous design safety review processes during the engineering and execution stages of any project I am working on. In my opinion, when comparing suppliers, one should focus their selection criteria on the most reliable and safe solution.

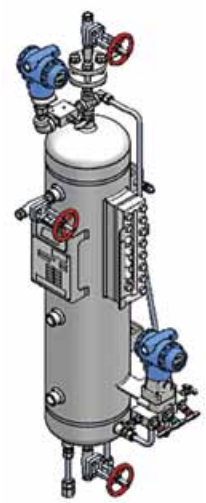
Interestingly, the same aspects of my job that prove to be demanding are also equally enjoyable, such as the design, engineering and troubleshooting problems of pumps, compressors and turbines. The more you learn the greater is your amazement at the thousands of technical solutions that mankind has developed to overcome various technical challenges. Even after 28 years in the industry I am still mesmerized and continue to learn new things.

PE: Can you tell me about the various types of pumps you have worked with?

Manjul: I have worked with a very large variety of pumps, such as centrifugal, reciprocating and rotary types. In 1993, having just joined Engineers India Limited, my department manager asked me to prepare the mechanical data sheets for the procurement of more than 40 pumps for an EO/EG (Ethylene Oxide / Ethylene Glycol) plant being engineered for an operator. Luckily, one of my senior colleagues guided me on how to carry out the preliminary pump selection, how to decide on the number of pump enquiries to be prepared, which data sheets to be used etc. Since then I have been involved in the FEED, engineering, construction and troubleshooting of thousands of pumps, ranging from less than 1 kW in size to as large as 25,000 kWs. My work experience has involved working with small



Seal Plan 52 (courtesy of Eagle Burgmann).



Seal pot for Plan 52 (courtesy of John Crane).

metering pumps per API 675, very large centrifugal pumps handling 14,000 m3/hr of sea water flow, very high pressure (45,000 kPa) water injection pumps driven by gas turbines and large main oil export line pumps of 1700 m3/hr capacity.

PE: Are there specific pump issues that you often encounter?

Manjul: Nowadays I am more involved in the root cause analysis of major rotating equipment failures. Some issues that I have encountered over the past 28 years would be high vibrations, mechanical seal leakages, coupling slips and failures, frequent bearing failures, poor lubrication practices and more. One morning in the earlier years of my career, I received a call from an engineer who was commissioning a process pump. He complained that on a number of pumps the mechanical seals, with seal plan 52, had failed. After some further discussion, I pointed out to him that the valve on top of the seal pot had to be kept open for the thermo-syphon system to work properly. After some scepticism and incredulous laughter the engineer went back, opened the valve at the top of all the plan 52 seal pots and commissioned the pumps without any further issues. After many years in the industry, I still first look for a simple explanation to the problem, and only after eliminating the simple things would I look at a more complex reason.

In oil and gas facilities there is a pervasive use of seal plan 53 to seal the hydrocarbon pumps. However, this hasn't resulted in the expected or desired higher reliability from the injection of clean sealant fluid in the seal area. Compared to a refinery or a petrochemical plant where pumps are usually in a closed loop service, the flow and the differential pressure of a pump in an oil and gas facility can change substantially over a period of time. I have come across many oil pump applications which are running at less than 50 percent of the design flow and differential head. The changes in the operating conditions have led to frequent failures of seals supported by seal plan 53. Seal suppliers, pump vendors and end users should systematically debate the suitability of the two seal plans; seal plan 52 versus seal plan 53 A, B and C.

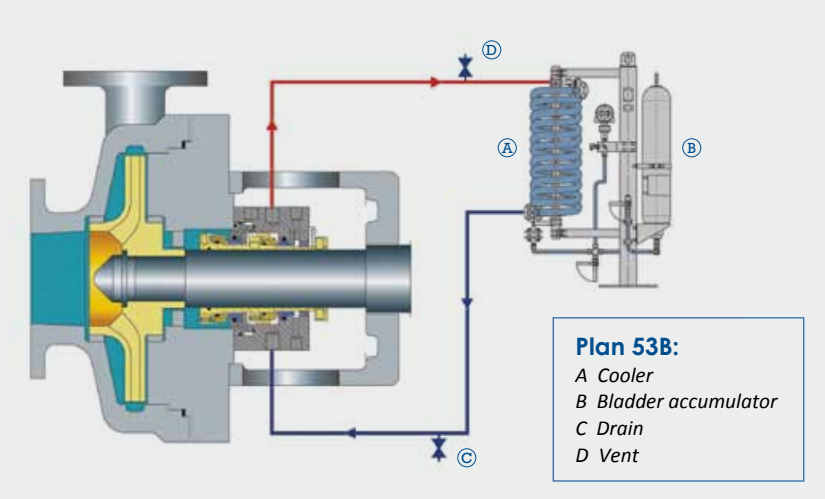
I would advise pump and seal vendors to further work on defining the operating envelop / guidelines for the sizing of auxiliaries supporting the mechanical seal. Across oil and gas facilities the average mean time between failures of the mechanical seals varies from 24 months to 84 months. This wide range has much to do with poor design of auxiliaries.

PE: Do you notice any trends that are occurring in the pump industry?

Manjul: There is an increase in the numbers of high pressure water injection pumps in oil fields. Pump vendors have not made the best use of finite element analysis (FEA) and other modern tools to conduct more sophisticated analysis of these high pressure pump designs. The efficiency and operating ranges have been fairly stagnant and the understanding of fatigue design is not comparable to the compression or turbine industry. I would encourage pump vendors to increase the use of these techniques in order to improve the understanding of hydraulic and cyclic forces within the pump and allowable operating range of the pumps.

Similarly, reliability benchmarking has suffered in recent years. There is real value in operators and suppliers getting together to develop common criteria to support better benchmarking of failure statistics.

Do not tolerate repeat failures or status quo. As the quality of the castings, forgings, machining and analytical technologies have improved, a good engineer should continuously endeavour for higher plant and equipment reliability and availability. Better knowledge

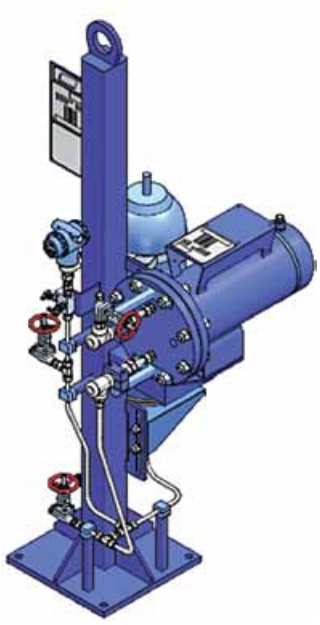


Sealing Plan 53B (courtesy of Eagle Burgmann).

will always help in developing and designing robust equipment, and all engineers should keep an open mind to new ideas and new solutions.

PE: What advice would you give to newly qualified engineers?

Manjul: I have a strong belief in the benefits of knowledge and experience. A trainee engineer can benefit hugely from learning from those around them. I would advise any engineer to spend some time in the field; the earlier in their career the better. The rotating equipment industry has always been very complex and demanding. Much knowledge is gained from spending time in the field, reading technical books and papers, by exchanging information with peers and attending technical seminars and conferences. Much of this knowledge can only be accrued if one is willing to spend the time that is needed to master this complex subject. I would recommend all engineers to maintain a small library of good reference books, preferably well thumbed through and full of notations and observations, which will help them to refine their thought process as they master the complex machinery design and its operating principles.



Plan 53B with water cooler (courtesy of John Crane).

Manjul Saxena is a Senior Rotating Equipment Engineer at BP, based in Surrey, UK. He has more than 28 years of experience in the industry and has worked all over the world for a variety of projects.