BACK UP ROLL NECK SEALING - BACK TO THE FUTURE [1]

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Abstract
Various back up roll sealing arrangements have been used over many years, these were mainly the Mesta two lip seals and the Morgoil 'X' type. This paper examines the customer driven improvements DanOil Bearings have made in this field.
Key words: Roll neck sealing.

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INTRODUCTION

The back up roll oil film bearings used on rolling mills have specially designed seals at the interface between the back up roll chock, the bearing and the roll. The purpose of the seals is to keep the oil in the chock and the process water out.
Ever since oil film bearings were introduced over 70 years ago, various sealing methods have been used with varying degrees of success. Over the last 30 years these were the Mesta two lip seals, the Morgan 'X' type seal and, most recently, the 'DF' type seals. The DF seal was designed as a replacement for the X type seal and many mills still use these today. Their effectiveness varies with different applications.
Since the formation of DanOil Bearings in the year 2000, some customers have asked for improvements to the DF sealing system.
As stated previously, the prime purpose of the roll neck seals is to keep the oil in the chock and the process cooling water out, two seals achieve this: a coolant seal and the roll neck seal.
The coolant seal is the first line of defence against water ingress. The next line is the seal inner ring that acts as a baffle and flinger, it also keeps the neck seal correctly positioned on the roll neck.
The next line is the neck seal. The X and DF seals were designed to keep oil in and water out of the bearing by contacting the seal end plate at two places and the roll neck.

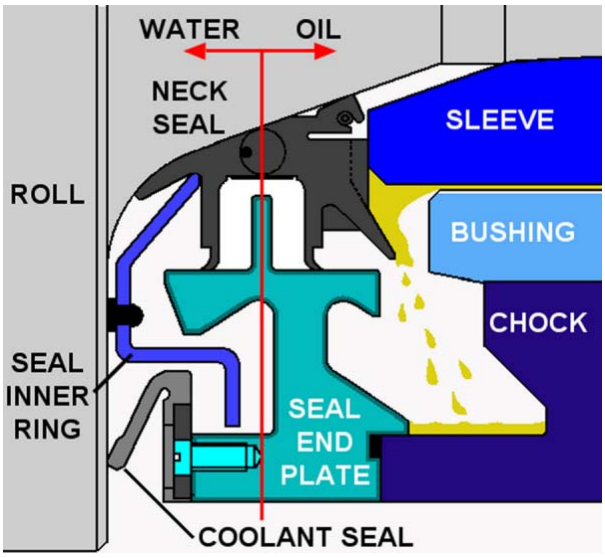

Figure 1. Typical DF or DDSSP

From DanOil's investigations into the sealing performance and service life, it was determined that when the coolant seals, neck seals and seal end plates are new, sealing is good but, as time increases, the sealing performance deteriorates.
For a long time DanOil engineers suspected that the ceramic coating on the seal end plate had a major influence on neck seal life. The ceramic coating is applied to prevent wear to the seal end plate sealing surfaces. In the manufacturing process, it is necessary to polish the ceramic on the sealing surfaces after it is applied and then seal

it with an epoxy. DanOil engineers believed that the epoxy coating applied to the ceramic wears from the pressure of the seal lips. Once the sealing coating has worn, the surface is more abrasive to the seal lips and causes the seal to prematurely wear out.
Also, the ceramic coating has a low thermal conductivity, which means that a greater proportion of the heat generated by friction during operation is retained in the seal lips. The increased heat at the seal lips causes the rubber to cure and become brittle thus loosing its resilience and it tends to crack. The water side seal lip is more prone to cracking because it is more likely to run dry if the coolant seal keeps the rolling solution out. Once the resilience has been lost, or cracking has occurred, sealing efficiency is reduced therefore oil loss and water ingress are more likely to occur.

DanOil DDSS-P Sealing System

DanOil Bearings have been working in close co-operation with a seal manufacturer to overcome these problems and have developed a direct replacement for the DF or X type sealing system that has much longer life. The system consists of a coolant seal, seal inner ring, neck seal and a seal end plate. The system is called the Danieli Double Sealing System – PTFE

Coolant Seal
The coolant seal has a continuous steel backing. It is fixed to the seal end plate using stainless steel screws. A section of the seal lip is removed at the bottom dead centre of the seal to serve as a drain. The lip of the seal has a strip of PTFE moulded into it. The PTFE strip reduces friction and the heat build up in the seal lip.

Figure 2. PTFE Coolant S

Figure 3 PTFE Neck Seal

Neck Seal
The DanOil neck seal has PTFE strips moulded into the lips to reduce heat generation due to friction. PTFE has a very low coefficient of friction. They are also more tolerant of high temperature operation and these two-fold advantages eliminate the hardening of the lips that leads to cracking and fluid loss in service.

Seal End Plates
The entire seal end plate is nitrided using the Nitreg process to prevent wearing on the sealing surfaces and corrosion of other surfaces. Although the primary purpose is hardening the seal running surfaces, the entire seal end plate is treated and provides corrosion protection. This is particularly useful in hot strip and plate mills where rusting occurs on normal seal end plates.
In addition to the changes in the surface treatment of the seal end plates, it was decided to remove the scrolling on the seal running surfaces. The scrolls, one left hand and one right hand on each sealing surface, were designed to act as a pumping groove to keep the water out and the oil in the chock. It was felt that this was of limited operational value and machining the scrolls increases manufacturing costs. The scrolling on the drive side seal end plate is the opposite of the one on the roll change side; this needs careful management and means that two spares must be available for one roll. Using plain seal end plates improves this situation and means that one spare can be stocked instead of two.

Operational Experience

The first seals DanOil bearings produced had very good results and customers switched to DDSSP seals. Close monitoring of the performance in service has lead to some minor refinements in the design and materials used.
By modifying the procedure of moulding the PTFE strip into the rubber seal, the service life improved. DanOil engineers also decided to slightly reduce the hardness of the rubber compound to further increase the life of the seal. With these improvements incorporated into the sealing system many customers are very satisfied with the performance of the sealing; however, some customers wanted a new sealing design.

Alternative Sealing Design
In the majority of designs, radial seals are static whilst the seal running surface rotates. However the DF & the DDSSP neck seals rotate with the roll and the seal running surface (the seal end plate) is static. This has the disadvantage that the seal lips are constantly flexing whilst the roll is rotating and this presents two scenarios:

1. On high speed mills the lips have to flex as much as 5 to 6 times per second and it may not be able to stay in contact with the seal end plate. This gets worse as the seal begins to harden with age.
2. On low speed, heavily loaded mills, the seal lips compress much more as they pass through the load zone of the bearing. When the seal hardens with age the lips take a permanent set and leaks are inevitable.

After working closely with customers and listening to their concerns, DanOil engineers have gone ‘Back to the Future’.

Description of New Sealing System

Instead of re-inventing the wheel, DanOil engineers went back in time and examined the old two lip seal designs to see what improvements, if any, could be made. The major difference between the two-lip system and the DDSSP system is that the seal is stationary and the sealing surface is rotating.

Based on the successful use of PTFE lipped seals and Nitreg hardened seal end plates in the DDSSP system we incorporated these features into the design shown below. The sleeve extension ring has been Nitreg hardened.

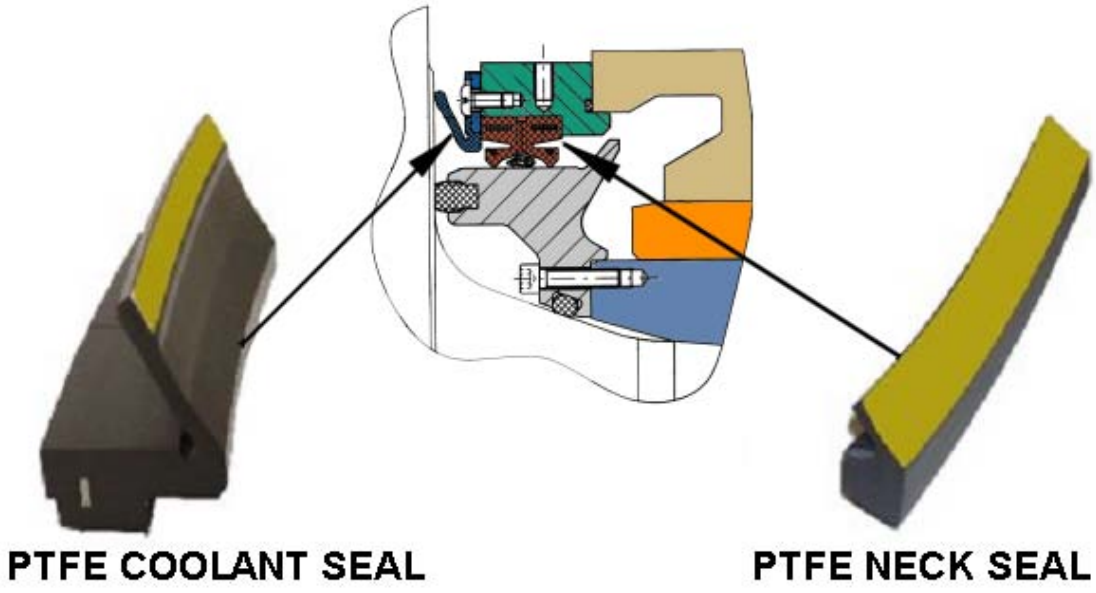

Figure 4. DanOil Two Lip Seal System

The sealing system is currently in extended trials in a hot strip mill in the UK. The early results have been very promising and monitoring will continue over the next few months to assess the advantages and any disadvantages of this system.

At the completion of a successful trial the client may well decide that looking back has evolved the sealing system of the future.