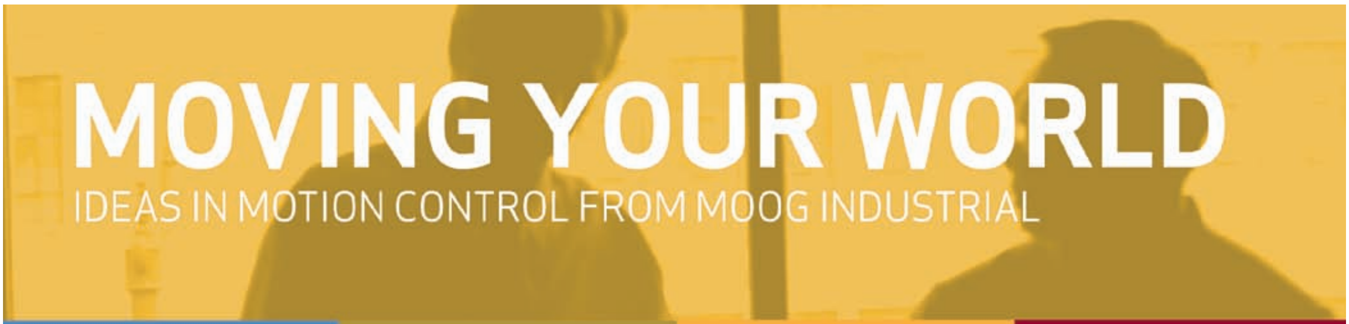


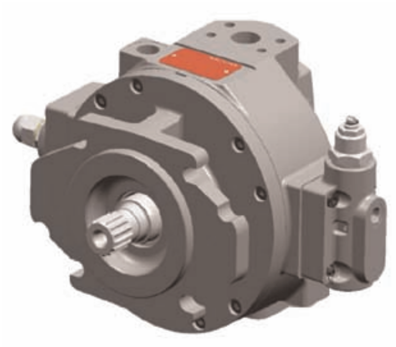

OCTOBER 2008 ISSUE 19

MOOG

## RADIAL PISTON PUMP FOR USE WITH HYJET® AND SKYDROL®

**CUSTOMISED FOR USE WITH PHOSPHATE ESTER HYDRAULIC FLUIDS IN THE AVIATION INDUSTRY.**

By Robert Luong, Product Marketing Manager for Hydraulic Products



*RKP Pump*

The Moog Radial Piston Pump (RKP pump) has been widely accepted for decades throughout the world in various marketplaces. Due to its design principle, users of the radial piston pump have benefited from advantages such as long life and lower noise.

When Moog started redesigning the RKP pumps in 2002, the primary objective was to respond to industry demands such as: improving reliability, lowering the noise emission, and offering maximum flexibility to users in providing adaptability for configurations of the application. By taking advantage of state-of-the-art technology, a new control option has been created featuring digital electronics and a fieldbus interface, supported by an advanced control algorithm and Moog configuration software.

Various measures such as a new stroke ring design, enlarged suction port, and increased number of pistons have been implemented in the second generation of RKP to meet the objectives. Since the introduction of the re-designed RKP-II in 2005, the pump has proven in the field that significant improvements can be achieved while continuing to offer the same high performance.

This was not the end of the product development activities. Far from it. Moog has utilized the versatility of the RKP design principle to its utmost. After internal analysis and testing of critical parts, Moog decided to extend its RKP-II line capabilities by offering an ATEX-certified version. The new enhanced version can be used in applications dealing with different types of fire-resistant aircraft hydraulic fluids such as Skydrol® to type V, LD4, 500B4, and HyJet®. These applied fluids have proven their ability to reduce aircraft fire hazards in the air and on the ground and offer lower viscosity compared to mineral oil based fluids. This characteristic allows a wide temperature range of operation, in particular at low temperature ranges.

Typical applications for this type of pumps are:

- Aircraft testing and repair facilities
- Airframe construction
- Aircraft hydraulic component manufacturing facilities

*continued on page 2*

*continued from page* 1

Displacements ranging from 19 to 80 ccm are available. All pumps feature a flow limiter, which allows mechanical adjustment of the maximum displacement. They can perform at a continuous pressure up to 350 bar [5,000 psi], and offer 2 different control options: pressure compensator (type F) and load sensing (type J). They are also designed for open circuits. To improve the design flexibility of Moog's RKP-II, the pumps are fitted with standard SAE-A and SAE-B flange arrangements, providing compatibility with third party pumps when operating in tandem.

A 12 month warranty is available. Furthermore our customers benefit from market-leading delivery times and worldwide technical support.

**TECHNICAL INFORMATION**

| | | | |
|---|---|---|---|
| Displacement cm³/rev | 19 | 32 | 80 |
| Theoretical flow rate at 1,500 rpm | 28.5 l/min (7.5 US gal/min) | 48.0 l/min (12.6 US gal/min) | 120.0 l/min (31.5 US gal/min) |
| Theoretical flow rate at 1,800 rpm | 34.2 l/min (9.0 US gal/min) | 57.6 l/min (15.2 US gal/min) | 144.0 l/min (38.0 US gal/min) |
| Maximum speed | 1,800 rpm | | |
| Type of mounting | Spline according to DIN 5480, 4 holes ISO flange according to DIN/ISO 3019/2 (metric, type B7) | | |
| Mounting position | Any | | |
| Type of drive | Direct Drive with coupling | | |
| Continuous pressure | 350 bar (5,000 psi) | | |
| Maximum pressure to DIN 24312 | 385 bar (5,500 psi) | | |
| Pressure peak | 420 bar (6,000 psi) | | |
| Hydraulic fluids | Skydrol® fluids up to Type V (Skydrol LD4, Skydrol 500B4, Skydrol 5) | | |
| Hydraulic fluid temperature range | -15°C to +50°C (5°F to 122°F) | | |
| Ambient temperature range | -15°C to +50°C (5°F to 122°F) | | |
| Viscosity | Allowable operational range 8 to 100 mm²/s (cSt). Recommended 16 to 46 mm²/s (cSt). Maximum viscosity 500 mm²/s during start-up with electric motor at 1,800 rpm | | |
| Filtering | NAS 1638, class 9, ISO/DIN4406, class 20/18/15 | | |
| Line connections: | High pressure series 350 bar (5,000 psi) according to ISO6162 | | |
| Pressure port | SAE 3/4" 6,000 psi | SAE 1" 6,000 psi | SAE 1 1/4" 6,000 psi |
| Suction port | SAE 3/4" 6,000 psi | SAE 1 1/2" 3,000 psi | SAE 2" 3,000 psi |

*Table 1 above shows a selection of technical data of the enhanced version of RKP*

***About the Author:***

*Robert Luong, holder of Bachelor's and Master's degrees in electrical engineering, as well as a MBA, Robert is a Product Marketing Manager for hydraulic products with Moog Industrial, and has been with Moog since 2001 in various Engineering and Marketing positions at different Moog sites worldwide. He brings 13 years of experience in automation technology.*

## A DEEPER LEVEL OF HIGH PERFORMANCE: MOTION CONTROL SOLUTIONS FOR OIL AND GAS EXPLORATION AND PRODUCTION

By Scott Scheffler, Project Engineer, Moog Industrial, East Aurora NY, USA

Imagine the North Sea waves thrashing up against your oil rig with the high winds trying to throw you off balance. Think about feeling virtually baked under the hot sun as you work on your rig in the Gulf of Mexico. Couple this with current never-ending thirst for energy and understand that you have a harsh and dangerous job to do.

Oil rigs are in some of the world's toughest environments and Moog offers innovative high-performance motion control solutions designed for today's critical oil and gas exploration and production applications.

Working with our customers in this industry, Moog has developed motion control solutions that improve the performance of downhole tools, rig and subsea equipment in a range of applications for this industry. These solutions help oil and gas professionals meet key challenges including:

- Oil exploration in off-shore and other hostile environments with increased drilling depths
- Enhanced recovery from mature fields
- Improving the return on investment for exploration and production
- Extended drilling times between trips

As the industry responds to such challenges with solutions that emphasize faster drilling, improved accuracy and quicker completion rates, Moog can help. We improve the reliability and performance of downhole tools such as:

- Rotary Steering Systems (RSS), a tool designed to drill directionally with continuous rotation from t he surface, eliminating the need to slide a steerable motor.
- Measurement While Drilling (MWD), is a tool that transmits information in real time from the tool, located near the drill bit, to the surface.
- Logging While Drilling (LWD), the measurement of formation properties during the excavation of the hole through the use of tools integrated into the bottomhole assembly. LWD has the advantage of measuring properties of a formation before drilling fluids invade deeply.
- Completion tools, the hardware used to optimize the production of hydrocarbons from the well. This may range from nothing but a packer on tubing above an openhole completion ("barefoot" completion), to a system of mechanical filtering elements outside of perforated pipe, to a fully automated measurement and control system that optimizes reservoir economics without human intervention (an "intelligent" completion).
- Production testing: a procedure that involves sampling gas and liquid at different points across the diameter of pipe to evaluate the degree of stratification at a specific location

We also provide precision automation for rig equipment and add productivity in subsea applications.

**New Challenges and Solutions**

Our down hole drilling customers are challenging us even further with a new technology called HTHP that is increasingly important as new market directives are pushing oil producers further offshore. HTHP, high temperature/high pressure, is synonymous with ultra deep water drilling defined as water depth over 1828 m (6,000 feet) with actual drilling depths over 6,100 m (20,000 feet). This will require even stricter guidelines and new designs to be tested and stretched to their limits. Unbelievable environmental requirements of 35,000 psi (2,450 bar), 300 C? (572 F?), 250 G shock are being placed on our components.

*continued on page 4*

*continued from page* 3

And here are a few of the key industry challenges that our global teams' are working to meet:

• Maximizing Tool time on bottom
Our expertise in the design and manufacture of premium quality servomotors, alternators, motor control electronics and actuators are combined to create motion control solutions that are ideal for severe duty applications with high reliability at the high temperatures that downhole applications demand.

• Positive impact on Rate of Penetration (ROP)
Moog solutions enable improved performance of directional drilling tools for higher efficiency in reaching pay zones (a reservoir or portion of a reservoir that contains economically producible hydrocarbons). Moog also has application-specific solutions for RSS, tractors, and wireline (related to any aspect of logging that employs an electrical cable to lower tools into the borehole and to transmit data), MWD, LWD and telemetry tools that enhance data transmission speed and reliability.

• Delivering higher precision for rig equipments
Our automation solutions cover pipe handling equipment, power tongs, rotary tables and brake control systems. In addition Moog quality servovalves provide safe reliable performance in exploration applications as on Vibroseis vehicles and subsea equipment like Remotely Operated Vehicles (ROVs).

**Case Study - Success through Collaboration**

A leading energy company sought to maximize productivity, increase operational hours and significantly reduce downtime related to equipment maintenance in an extremely harsh operating environment. Through close collaboration with the company's engineers, Moog tailored a solution that provides optimal performance in some of the world's most severe ambient conditions.

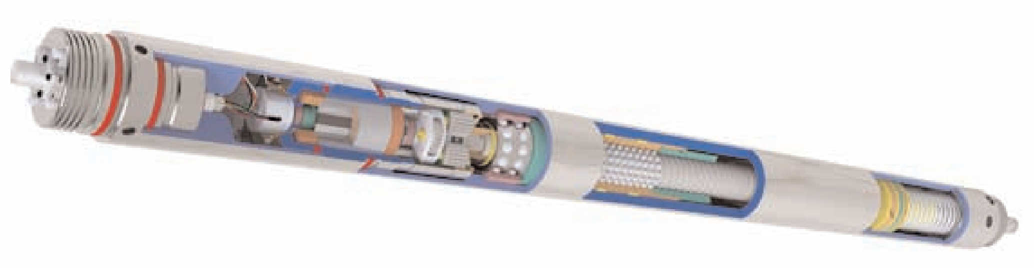
This company requested that we provide fully assembled and tested servomotors and alternators that meet strict performance specifications, deliver continuous power for higher output and work flawlessly despite tight space constraints.

Using a variety of Moog building block components, we designed a rugged servomotor within a unique package constraint that achieved the desired application's speed and torque requirements. We also delivered a robust alternator for a given voltage per RPM range and load.

The resulting solution exceeded the customer's expectations for productivity and performance in some of the world's most unforgiving environments.

**Building Blocks for a Turnkey Solution**

**Electro-mechanical actuators** provide precision actuation with integrated motor, gearing and ball screw for compact design. Ideal for use in completion, formations testing and inspection tools.



*Force range: capabilities over 100,000 lb peak*
*Speed range: up to 30 IPS*
*Stroke: up to 60 in.*
*Motor voltage: range from 24 to 1,000 Vdc*



*continued on page 5*

*continued from page 4*

**Brushless Servomotors** are customer designed for demanding downhole drilling applications. They offer high performance, reliability and a long service life

*Voltages from 24-1,000 Vdc*
*Existing sizes: <1.00 in. – 10.0 in. outside diameter*
*Speed range: Up to 10,000 RPM*
*Power Range: 7.5 kW*

Moog **alternators** are application-specific and provide a reliable power supply to critical downhole tools.

*Voltage range: 24 – 600 Vdc*
*Speed range: up to 8,000 RPM*
*Power: 50-50K watts*

Moog also offers oil and gas motion control solutions for rig equipment and subsea equipment.

Simply put, Moog's mission is to deliver the flexibility, innovations and collaborative expertise you need for a smart approach to your most difficult engineering challenges.

***About the Author:***

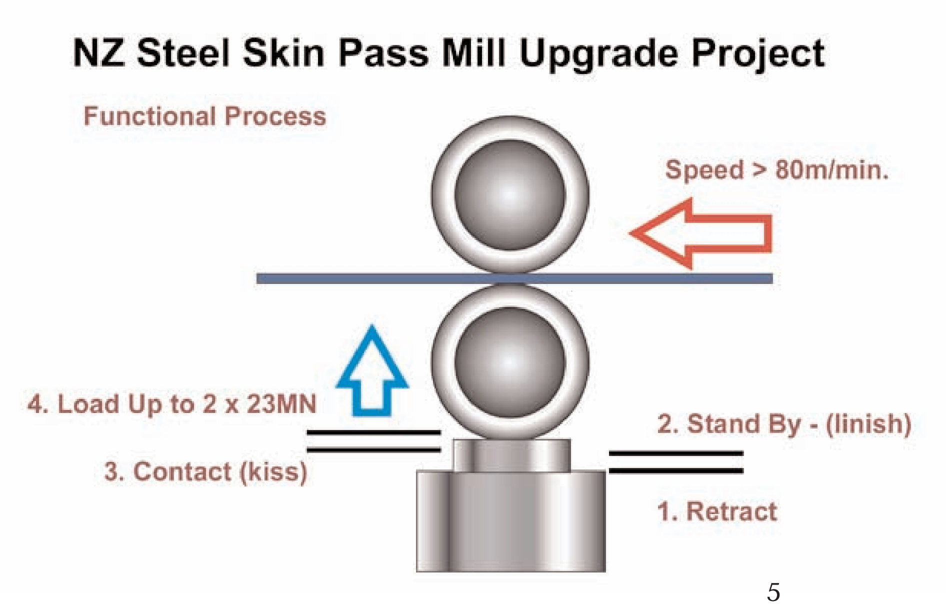
*R. Scott Scheffler has over 15 years experience in engineering, systems integration and sales in the motion control industry including the past 4 years as Project Engineer for down hole oil drilling products. He has a B.S. degree in electrical engineering from State University of New York at Buffalo and a Masters of Business Administration degree from St. Bonaventure University.*

## ELECTRO-HYDRAULIC SERVO CONTROL SYSTEM UPGRADE FOR STEEL SKIN PASS MILL

By Jeff Jones, Technical Service Manager, Moog Australia

Customers of galvanized steel sheet in New Zealand are enjoying products with improved surface finish, thanks to a Skin Pass Steel Mill Upgrade Project at New Zealand (NZ) Steel for which Moog provided a specialist control system and hydraulic engineering expertise.

NZ Steel's refurbished plant boasts a new electro-hydraulic servo control system, and the project highlights Moog's engineering expertise in applying high performance electro-hydraulic technologies to plant upgrades.




Skin pass milling is a post-processing process used to improve the surface finish of cold-rolled or coated steel (the process is explained in more detail in the panel). It can be a single or multiple roll process (the NZ Steel unit is a single, two-high roll stand) and typically can apply forces up to 2.5MN (562,000 lbf) per side for a 1.5 m (59 in) wide sheet. The actual force load applied varies according to input parameters, such as surface finish and thickness.



*continued on page 6*

*continued from page 5*

In this case, the line is part of the metal coating Galv line (galvanizing) process. Users of the product from this line are typically in white goods, roofing, cladding and structural sections.

In early 2006, Global Hydraulics & Controls (GHC), Moog Australia's New Zealand Value Added Reseller (VAR) asked Moog to assist in bidding for the upgrade of a Skin Pass Mill control system. Pitted against international competition, it was important for GHC to submit a proposal with a superior technical solution which was locally supported and provided a value solution to NZ Steel. After much discussion including onsite demonstrations by Moog and GHC of the Moog Servo Controller (MSC) platform, GHC was awarded the contract for the upgrade. Key elements of the success included the proposed team of GHC together with the specialist engineering support of Moog Australia for the control and hydraulic solution.

Integral to the upgrade project was the challenging requirement to switch the new system into the production line within four days, during a planned plant shutdown. The system had to function immediately with no time possible for trouble-shooting or tuning. To ensure this happened, a dummy mill stand was built by GHC and run in parallel to the main line to test and confirm the functionality of the Moog control system and 100% validate the interface with the NZ Steel CITEC host control system. Detailed event maps were established for every part of the process to ensure the Skin Pass functionality and control responsibility was maintained between the Moog controller and the NZ Steel CITEC system.

Peter McArley of GHC was the project manager, leading the GHC team in putting their proposal together, winning the business and managing the execution of the project. Peter was supported by Moog Australia's team of Peter Heitmann, Business Development Manager, Jeff Jones, Chief Engineer and engineering team. On the customer side, NZ Steel's Principal Engineer Damien Little acted as Project Leader. His role, besides overall project management, was to establish that the control strategies implemented met the requirements of the process. He was supported by Project Engineer John Sayer.

The existing mill stand was an over 30 years old SACK design and was no longer supported by the installer. Spares were hard to come by and in-house maintenance expertise had been dwindling.

The control strategy specification was established in conjunction with NZ Steel engineers during a pre-commissioning phase period of three months from project order to placement. It involved establishing the expected performance parameters, operator control interface and communication protocol (Industrial Ethernet IP) between the Moog controller and the upgraded Allen Bradley-CITEC line control system.

A major benefit is that it is now possible for the set-up to be carried out by a trained technician rather than a controls engineer, with integrated control being provided within the setup parameters, including valve drive limit, ramp rates, and gain and drive characteristics.

In operation, the process control requires the roll to be lifted onto the sheet ('kiss') before applying a controlled load. The control, although simple in concept, is in reality complex, as one side of the roll, although synchronously controlled, will reach the sheet before the other due to misalignment errors caused by measurement limitations or different play in the roll bearings.

The solution was to synchronously lift each side of the roll onto the sheet under position control with a low level force over-ride – the roll is lifted up to the sheet but is limited by a force override outer control loop until both sides of the roll make contact and the bearing play in the top roll is taken up. The transition from position to the low force control is seamless.

This initial force is enough to lift both rolls but not enough to risk grabbing or jamming the sheet. This is essential as it could mean up to 500 m (1640 ft) of product could be lost and as much as two days of production downtime incurred while the line was reset.

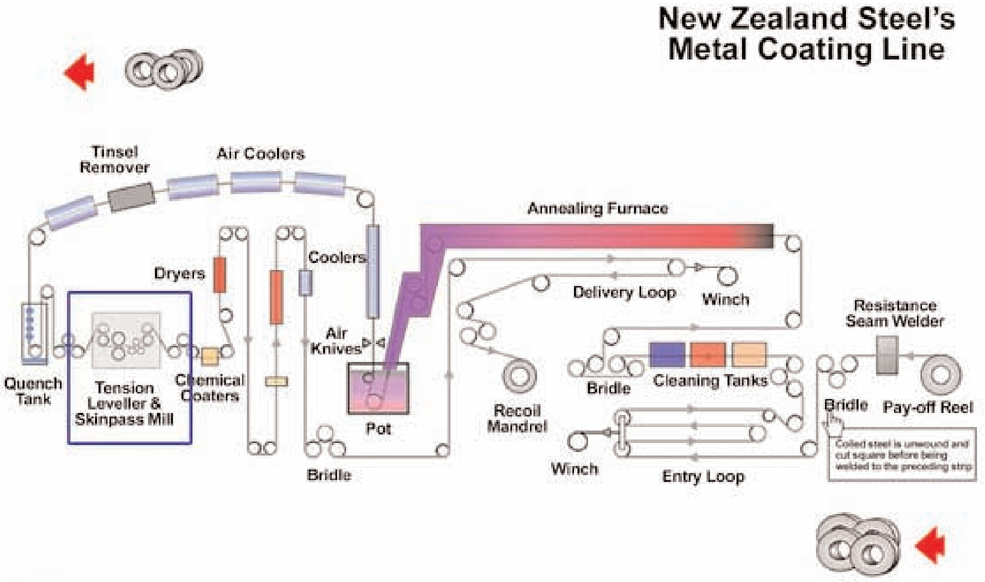
Once both sides are in contact and all bearing play is removed, the force is ramped to the required process level with near zero overshoot.

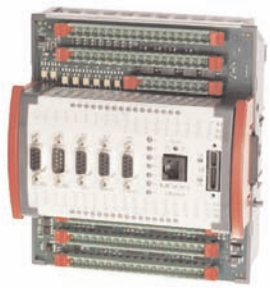


*continued on page 7*

*continued from page 6*

# NZ Steel Skin Pass Mill Upgrade Project



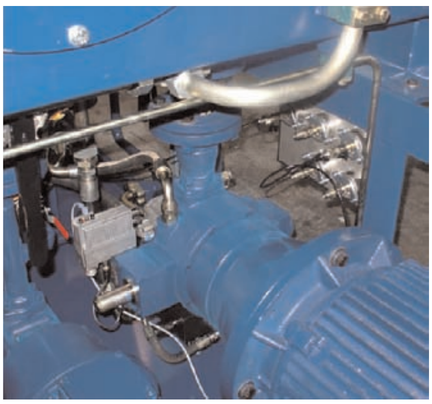



*MSC Digital Microprocessor*

The low level control (known as the skin pass roll control) is implemented using the MSC digital microprocessor- based controller. The control strategy implemented within the MSC was designed and programmed by Moog engineers. It was based upon a detailed analysis of all operational modes of the process ensuring a robust, high integrity solution. The controller provides the closed-loop position movement and force control for the skin pass roll and also includes the management of the auxiliary hydraulic valves operating the actuators and the supporting hydraulic power unit , the design of which is also integral to the upgrade - because as the line operates continuously, so must the power pack. The system allows high levels of pre-emptive management to be implemented, resulting in higher productivity and more user-friendly working environment.

The new system required replacing the existing servovalve manifold assemblies, which control each of the load cylinders. These are effectively displacement rams, relying on the weight of the roll to retract. However, in the emergency mode, a powered retract is required in order to quickly and reliably move the roll off the sheet.

The Moog products used were a Moog Direct Drive High Performance Servovalve (DDV) and hydraulic cartridge valves, which have electric feedback control (EFB) and position feedback, enabling the high level of safety interlock and pre-emptive management within the process, which is now possible, due to the application of modern digital microprocessor-based products within hydraulic systems.



*The new system has now been operational for more than 18 months with high reliability and no down time due to the Skin Pass control process.*

The selected design uses two Moog Radial Piston Pumps version with Digital Control (RKP-D), high performance variable displacement pumps with a digital electronics. The RKP-D controllers seamlessly enable the pump pressure and flow to be regulated according to the system demand thus minimizing the power used and enabling the system to be optimally tuned, so that transitioning from one pressure level to another avoids (via ramping and level limits) the possibility of overshoot, as this could potentially damage the product. This result is particularly significant, as the hydraulic control mode for the load cylinders is open-loop switching of direct control valves when lowering off the sheet.



*continued on page 8*

*continued from page 7*

*Steel Skin Pass Mill Upgrade Project – Summary Specification*

| | |
|---|---|
| Operating Range | 50 – 250 bar (725 – 3600 psi) |
| Pressure | repeatability to 0.25 bar (3.6 psi) |
| Position: static error | < 0.1 mm (< 0.004 in) |
| Tracking error between axes | < 0.2 mm (< 0.008 in)Roll mass |
| Roll mass | 10,000 kg (22,000 lbs) |
| Raise | 8 mm/s (0.32 in/s) |
| Lower | 10 mm/s (0.4 in/s) |

**What does a skin pass steel mill do?**

In this process the cold rolled annealed strips are given a desired surface finish. It improves the flatness and suppresses the yield point elongation. Anti rust oil is used on strip surface as protection from rust.

Two major categories are to be considered as far as steel surface is concerned; namely cold-rolled steel and hot-rolled steel. All steel is originally hot-rolled, while some of it goes through the cold rolling process later. Basically, hot-rolled means that the steel is heated in the furnace to a cherry-red temperature and then passed through a series of rolling mills to reduce it to the desired size. When cold-rolled steel is wanted, the hot-rolled steel is reduced only part of the way in gauge and then allowed to cool and then finally passed through a series of reducing mills without further heat being applied to the metal. As metal is worked from one reducing mill to the next, the grain structure is rearranged in such a manner that the steel becomes harder and more brittle. To offset this embrittlement the steel must be periodically "softened' or annealed between cold working operations. Annealing is accomplished by passing the metal through a furnace again, heating it to a cherry-red temperature. These extremely high heats actually burn the surface of the metal thereby producing scaly deposits that makes it necessary to pass the metal through an acid pickling tank after annealing and for a second time just before the final cold-working. The second pickling operation is a 'must' if an even and brighter surface is to be expected. The burning or oxidation can be largely prevented, however, by passing the metal through what is known as an atmospherically controlled furnace. In this type of furnace all oxygen has been removed, thereby eliminating any possible scale production. Without oxygen no oxidation can take place, therefore the metal emerges in much the same condition surface wise as when it entered the furnace.

There is a definite difference in the amount of reactivity to chemicals between hot-rolled and cold-rolled surfaces. Cold-rolled, steel has a much finer grained, smoother and less porous surface. This is so because cold rolling tends to 'fold in' and close up the pores. The less porous the surface, the less surface area is presented to chemical attack by acids, alkalis, and phosphating compounds. By the same token, soft hot-rolled steel is more porous and therefore more reactive to chemicals than is hard, tempered steel. With soft steel the metal is cold-worked and then annealed just before the final pass which is a light 'skin pass' through the rolls which reduces thickness no more than 50 microns. This amount of final cold reduction is not enough to close up the pores as much as hard tempering, in which the steel is reduced by several cold rolling passes after annealing, giving it a shinier surface.

***About the Author:***

*Jeff Jones is Technical Service Manager of Moog Australia, employed since 1980 in Melbourne and previously at Moog Germany for 8 years. He holds a Bachelor of Engineering from Monash University in Melbourne and has wide ranging engineering experience within Moog.*