MOVING YOUR WORLD
IDEAS IN MOTION CONTROL FROM MOOG INDUSTRIAL
MARCH 2007 ISSUE 14 MOOG

FEATURE ARTICLE

MOOG'S NEWEST SOLUTIONS FOR THE STEEL MILLS IN CHINA AND INDIA

By Lance Li, Business Development Manager, Heavy Industry & Project Business
and K S Shiva Kumar, Regional Sales Manager, Moog in India

While steel mills are sometimes considered to be "old-style" manufacturing, there are many examples where some of the latest motion control technologies are being used for new mills as well as retrofits. Steel mills represent an interesting challenge as advanced technologies must be used in demanding environments. These environments include exposure to extensive heat, dirt and the rigors of a 24/7 operation. Moog has long been a leader in providing Servo and Servo-Proportional Valves to most of the world's well-known steel mills. This article focuses on some of our newest solutions for special applications in the booming China market and an innovative retrofit project in India.

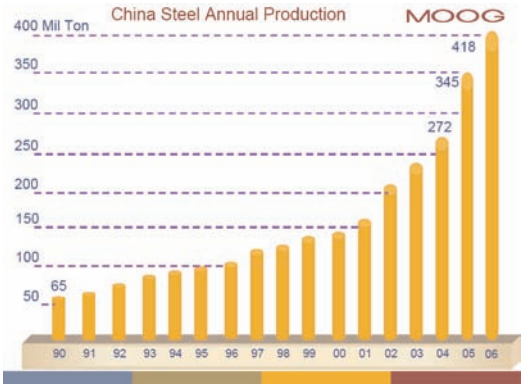
Over 100 Moog servovalves are used in this newly built 1750 Hot Strip Mill production line.

Steel Production in China

There is no doubt that China is the largest steel production source in the world. In 2006, the total crude steel production in China was 418 Million tons, that's more than 1/3 of the steel production in the world. The total investment in the heavy industry market is about 212.88 Bil RMB (26.95 Bil US$). In the past 10 years, the overall technology of the steel industry in China has greatly improved. The product structure has been constantly optimized and international competitiveness has been enhanced. Looking into 2007, analysis of both domestic and international demand suggests that steel production will increase another 10%.

Some exciting developments currently impacting the steel industry in China include:

- Shougang Group, a steel giant based in the Chinese capital of Beijing, will complete its massive relocation to Tangshan, Hebei Province by the end of 2010.
- Shanghai Baoshan Iron and Steel Corp (Baosteel) has built a new steel factory in the southern city of Zhanjiang.
- Wuhan Iron and Steel Corp has built a modern iron and steel works in Fangchenggang, also in southern China.
- Angang Steel Co. has started its new plants in Yingkou in north-eastern China.



In such an exciting environment, Moog can provide proven products and new solutions based on years of experience in the market. The following two examples are applications where Moog in China recently offered solutions.

Pipe Cutting Machine – Cutter Feeding System

A large steel maker in China is building a pipe mill production line and needed a specialized pipe cutting machine. The steel pipe's diameter can be larger than 220 mm (8.66 in) and has several different sizes. The most challenging

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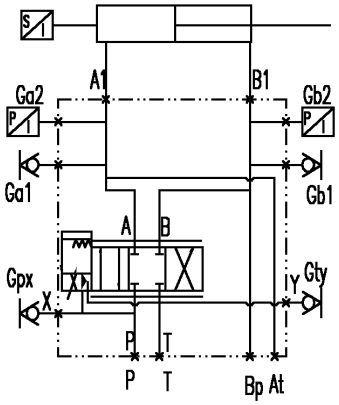
requirement is that the pipe can be as long as 20 m (65 feet) after milling. It varies from a normal lathe machine as a jig clamps and turns the pipe and a cutter then feeds into the pipe to cut it.

To meet these requirements, Xi'an Heavy Machinery Research Institute designed a pipe cutting machine which features a long holder table to fix the long pipe, and a complex revolving cutting head turning around the pipe. The cutter is mounted on the turning head and a servoactuator controls the cutter's precision cut into the pipe using a cam system. Considering the tolerance of the pipe during the cutting process and the extreme speed of the operation control of the cutter, feed position and speed are vital for quality and for preventing damage to both the pipe and the cutter itself.

Moog in China cooperated with Xi'an Heavy Machinery Research Institute by supplying the servoactuator, the M3000 Servocontroller System and the Moog Axis Control Software (MACS). As the cam for feeding the cutter is a non-linear system, and in order to get better cutting quality and higher cyclic efficiency, the actuator needed to follow a customized special position and velocity curve very accurately. For example, the cutter should touch the pipe softly in the beginning and keep a constant speed during cutting. This new system is currently being commissioned at the customer's site.

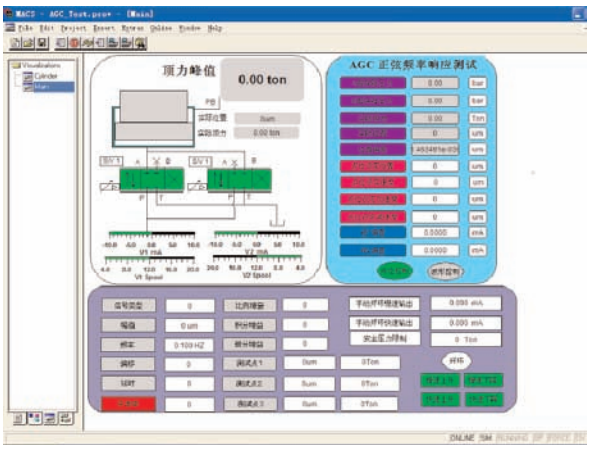


Schematic of Moog Servoactuator

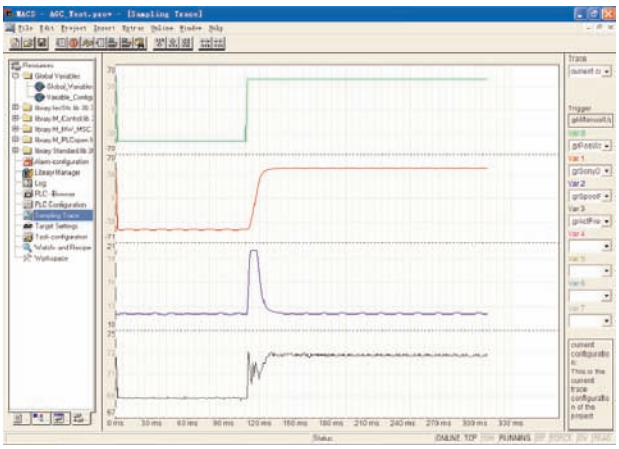
China CISDI Engineering Co., Ltd - AGC Actuator Test

About 10 years ago, some local Chinese OEMs started to manufacture rolling mill equipment including large size, highly dynamic and accurate AGC actuators. Recently, many OEMs began to take a system approach to dynamic performance. In the past, performance was normally evaluated on parameters such as friction, force, smoothness, speed, and pressure to understand the performance of individual components like cylinders and servovalves. For the servoactuator that was used for the full hydraulic AGC control in this high speed hot strip rolling mill system, it was necessary to understand how the servo loop works to assess the performance of the whole system, not just evaluate the performance of each individual component.

In 2005, China CISDI Engineering Co., Ltd requested our help with a 1750 Hot Strip Mill Project, where approximately 100 Moog Servovalves were used in that production line to cover all servo closed-loop control functions. We helped them to design a solution for an on-site test for actuator performance by supplying a M3000 digital servocontroller and MACS control software. We cooperated with CISDI and Beijing MECC, the hydraulic system manufacturer, for the successful implementation of on-site testing.



Moog M3000 Digital Servocontroller interface used in AGC actuator performance testing



AGC actuator step response test record

Some key parameters the testing monitored for the actuator were position accuracy, hysteresis, step response and frequency response. The test results helped CISDI understand the whole AGC actuator system performance and enabled smoother commissioning in end user sites.

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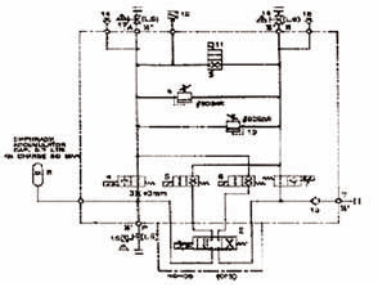
Steel Production in India

The Indian steel industry is nearly a century old with Tata Iron and Steel Co. being the first integrated steel plant set up in 1907. The industry has grown and now India is the 9th largest producer of steel in the world. The finished steel production in India has grown from a mere 1.1 million tons in 1951 to the current level of around 38 million tons. While the growth in the steel sector was formerly in the public sector units, the situation has changed dramatically in the decade from 1990-2000, with most of the growth originating in the private sector.

Currently, India has come out with a National Steel Policy with a long term goal that India should have a modern and efficient steel industry established according to world standards and catering to a diversified steel demand. This will require indigenous production of over 100 Million Tons (MT) per annum by 2019-20. The following example is an application where Moog in India recently offered a retrofit solution.

Mukand Ltd. - Hospet Division – Billet Caster Retrofit

Another unique application recently completed by Moog in India for a local steel mill was the billet caster project with Mukand Limited also called Hospet Steel. This location has been in operation for 10 years and manufactures billet and bloom cast steel. Their present capacity is 400K Tons and they plan to increase to 1M. Tons in 3 years.



Hospet Steel had some demanding requirements for their solution that were both technical and environmental. They were seeking to improve quality by eliminating pores or blow holes and increase productivity of the billet casting by implementing an Automated Mold Level Controller (AMLC). It was also critical to upgrade from a manual to an automated system to eliminate human errors in a high production environment. An important consideration was that the solution needed to be robust and withstand an environment with dusty and humid conditions. They preferred to use local vendors with a proven track record because they needed long term local support which included technical, repairs/spares and training services.

Moog was selected to partner with the customer based on an innovative turn-key solution approach. This included hydraulic manifold blocks and servoactuators built to suit the customer's requirement (D633 Servovalves and the M3000 Servocontroller). Our application engineers created customer-specific software using the sample tracing capability of the MACS Software.

Manifold Bloc with actuator.

The AMLC project was cited by the customer as highly successful as it achieved high accuracy in maintaining control of liquid molten metal. Production cycles were improved sharply while maintaining an operation with 99% efficiency without a breakdown. Most importantly, the quality of the customer's products increased sharply, even considering the increase in production due to high demand for the billet steel.

About the Authors:

Lance Li has been the Business Development Manager, Heavy Industry & Project Business for the past 2 years. He has worked with Moog for 10 years in China and has over 20 years experience in Hydraulic industry. Lance was a University professor before he joined Moog.

K S Shiva Kumar has been the Regional Sales Manager in Hydraulics group for the South & Eastern part of India and SAARC countries for Moog Industrial operations for 8 years. He has more than 14 years experience in hydraulic industry with focus on industrial closed-loop electro hydraulic applications.

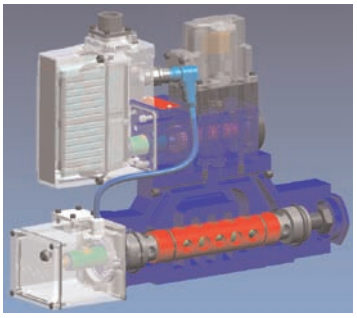
PRODUCT SPOTLIGHT

ROBUST AND PRECISE: THE D672 SERVOVALVE IS IDEAL FOR HEAVY INDUSTRY APPLICATIONS

By Jürgen Hutzler, Senior Product Engineer, Moog in Germany

The designs of Moog's servovalves are based on a thorough knowledge of our customer's motion control applications and their unique requirements, practical experience gained in the field and the use of innovative R&D technologies.

All of this know-how has been incorporated into the design of one of our newest products, the D672 Servovalve, a three stage size NG 16 servovalve featuring electrical feedback for the main stage and an NG06 pilot valve with a ServoJet® pilot stage. The digital valve electronics for closed-loop control of the pilot and the main stage are on the pilot valve.



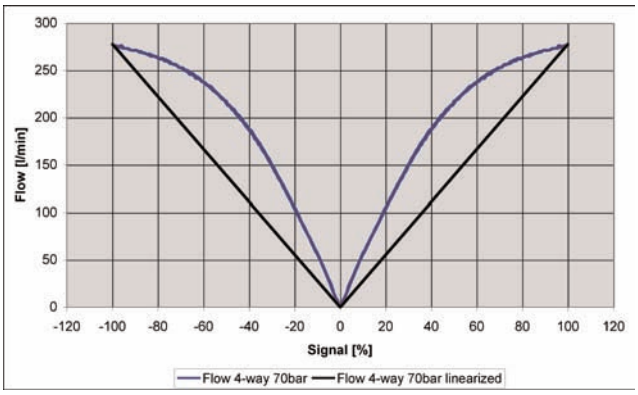
D672 Servovalve – 3-Stage with EFB Main Stage and ServoJet® Pilot

The D672 Servovalve is ideally suited to demanding environments such as steel mills due to:

- Highly dynamic valve behavior
- Rugged, dirt-resistant valve design
- No o-ring for the bushing inside the valve body and hardened steel construction for long service live
- Ability to modify the flow characteristic curve to suit the customer's application

Rugged Valve Construction

Both the pilot valve and the main stage have a spheroidal-graphite cast iron valve body and a spool/bushing unit made from hardened steel without an o-ring. In such spool/bushing units without an o-ring, the pressure port "P" for the "A" and "B" ports is sealed simply by the joint between the bushing and the aperture in the valve body. Thus, only the outside of the bushing is sealed using o-rings which are subject to low hydraulic pressure resulting from fluctuating load conditions and pressure peaks.



Flow vs. signal curve

The combination of a dirt-resistant ServoJet® pilot stage and a hardened spool/bushing unit without an o-ring for the pilot and main stages makes for a rugged valve with a long service life which complies with the latest ISO requirements.

Achieving Customer-Specific Performance

The sophisticated valve electronics allow for a linear characteristic flow curve as standard despite valve saturation and for the characteristic curve to be adapted to suit the customer's specific application.

New Port Pattern

The D672 Servovalve is the successor to our well known D791 design, a main-stay of steel plants around the world. Please note that the D672 valve has a mounting pattern according to ISO 4401-07-07-0-02 and the D791 valve has mounting pattern according to ISO10372-06-05-0-92. When replacing a D791 in an existing application with the new D672 a mounting manifold block can easily be used to accommodate the two different mounting patterns.

see chart top of page 5

About the Author:

Jürgen Hutzler is a Senior Product Engineer responsible for new product development for Moog's Servo and Servo-Proportional Valves (D661, D662, D665) including development of the new NG16/25 Servovalve with Pilot D670. He has worked at Moog since 2000 and previously worked for 3 1/2 years for Vickers and Rexroth.

Appendix: Technical Data Servovalve (D672)

Model...Type			D672 Servovalve
Mounting pattern			ISO 4401-07-07-0-02
Valve version			4-way
			3- stage with bushing
Pilot stage			D670
Pilot connection	Optional, internal or external		X and Y
Mass		kg	11.5
Rated flow	(±10%) at _pN=35 bar per land	l/min	160/260
Operating pressure	max		
Main stage:	port P with X external, A, B	bar	350
	port T with Y internal	bar	210
	port T with Y external	bar	350
Pilot stage:	regular version	bar	280
	with dropping orifice (on request)	bar	350
Response time*	for 0 to 100% stroke	ms	8
Frequency response*	90 ° phase lag, ±5%	Hz	125
Threshold*		%	<0,02
Hysteresis*		%	<0,2
Null shift	with _T=55K	%	<2,0
Null leakage flow*	total max. (~critical lap)	l/min	4,5
Pilot leakage flow*		l/min	1,7
Pilot flow*	max., for 100% step input	l/min	23
Spool stroke		mm	±3
Spool drive area		cm_	1,86

* At operating pressure p=210bar (3000 psi), fluid viscosity of 32 mm_/s (0.05 in_/s) and fluid temperature of 40° C (104° F)

ASK THE EXPERT

ASSESSMENT OF SERVOVALVE DESIGN FOR SPECIAL FLUID USAGE

by Mark Ludlow, Design Engineer, Moog in USA

The benefits of fire resistant fluids in steel mill hydraulic systems are obvious and there are several types of fire resistant fluids on the market. The push to convert to a safer fluid does not always become a top priority until there's a fire. This was the case last year at an Alabama steel mill. Much of the hydraulic system was destroyed and is now being redesigned in preparation for a switch to a water/glycol fluid. This very unfortunate incidence created a need for Moog to help with specialized technical assistance and service.

The original hydraulic system was designed for use with mineral oil and Moog worked with the pump manufacturer that the customer selected to review and revise the entire hydraulic system to provide robust operation on water/glycol. Moog Servo and Servo-Proportional Valves were used in the original system and had provided the customer with excellent service. The challenge was to evaluate whether existing designs would require modification for the new fluid. While most of Moog's Valves products are designed with mineral oil systems in mind, field experience has shown they will work well with almost any hydraulic fluid. In most cases a seal compatibility and system pressure check are the recommended protocol to verify acceptable operation with a special fluid. The critical nature of this application meant that a special analysis was needed to ensure high performance and long service life of the valves.

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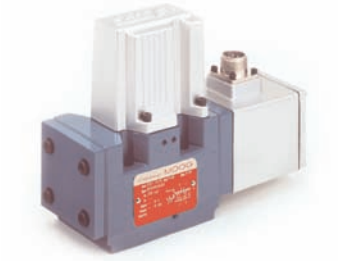
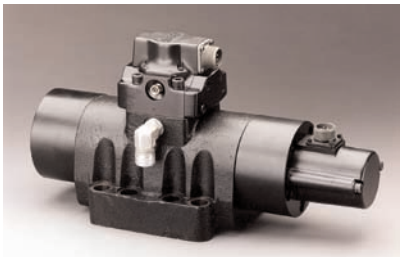


D661 Servovalve



D792 Servovalve

ASK THE EXPERT *continued from page* 5

One of Moog's distributors (Flow Dynamics) is the first line of contact for this mill. Moog's application engineers worked with the pump manufacturer and the distributor to create a plan for successfully testing the valve as part of the new system. In preparation for a meeting with the mill's maintenance supervisor, Moog Applications Engineers polled several other steel mills across the country and collected pertinent information from other users of Moog valves on water/glycol fluids. Moog Design Engineering created a bill of material compatibility chart listing the materials of all of the wetted parts in each of the valve models used in the system and verified that they were acceptable. The meeting provided an open forum for the sharing of experience and opened up the communication channels for everyone involved. All of the companies left the meeting with a mutual understanding of each other's product and can now proceed with confidence in the changeover effort. To ensure the success of this changeover, Moog has recommended that the steel mill send in valves for periodic review and analysis to ensure the optimum running of the new system.

Related Products and Services

Moog has extensive experience in applying products and solutions for the unique needs of steel mills. In addition to the servovalves mentioned here, Moog's RKP pump design is well-suited for special fluids in general and all sizes are suited for water glycol. For water glycol applications, we recommend a maximum pressure of 210 bar (3,000 psi) but experience in the field has shown that customers have run a water glycol application with 280 bar (4,000 psi) without problems.

Moog also provides customized products for the steel industry application including explosion-proof products. Other engineering services related to adapting valves to the demanding environment of steel mills include a range of recommendations to resolve potential issues of stability due to viscosity and stiffness when using non-standard fluids.

About the Author:

Mark Ludlow is a Design Engineer who is responsible for developments in Moog's Mechanical Feedback Servovalves. He has been with Moog since 1984 working in applications, product and development engineering. He graduated from Buffalo State College in 1983 with a BT in Electro-Mechanical Engineering.

HOT WEBSITES: STEEL AND IRON WEBSITES FOR MORE INFORMATION:

International Iron and Steel Institute
www.worldsteel.org

The International Iron and Steel Institute (IISI) represents over 190 steel producers that produce around 60% of the world's steel. This site, and the Institute, provide a forum for their members to address the major strategic issues and challenges it faces on a global basis. IISI also facilitates the benchmarking of best-practice among its members in all aspects of the steel business.

Association for Iron & Steel Technology
www.aist.org

The Association for Iron & Steel Technology (AIST) was established with a goal of advancing the technical development, production, processing and application of iron and steel. AIST presents technical meetings, conferences, exhibits and publications to serve those involved in the iron and steel community, including steel manufacturers, suppliers, consumers and academics.

The Iron and Steel Institute of Japan
http://www.isij.or.jp/e_index.htm

This site regards itself as an academic society for researchers and engineers in the field of iron and steel. It offers bulletins, journals, meetings, international exchanges, various publications, and seminars and allows for comprehensive searches on its extensive database.

American Iron and steel Institute
www.steel.org

Chiefly designed to promote the strategic needs of the North American steel industry this site features case studies, newsletter fact sheets, position papers and an extensive steel glossary and links.

DID YOU KNOW?

MOOG IS EXPANDING AGGRESSIVELY IN THE ASIA PACIFIC REGION

By Gary Inwood, Marketing, Moog in Japan

In the past six months Moog has established three very important new facilities in Korea, Japan, and China. This new investment will strengthen Moog's customer service and sales capacity to cope with the continued growing demand for power generation, plastics molding, steel production, metal forming, and automotive and aerospace testing solutions in the Asia Pacific region.

Moog's Korea Facility

The first expansion is an office and production facility opened in Korea in August 2006. The new facility located in Incheon City has a site of 8455 m2 (91,000 sq ft) and a floor area of 1962 m2 (21,120 sq ft). It is equipped with state-of-the-art repair capabilities for Moog's motion control products and manufacturing space for actuators, servomotors and electronics. The opening of this new facility in Korea now allows Moog to provide full systems solutions to its customers in Korea.

Yokohama's bay area,
Moog office building is second from left

The expansion process continued in November 2006 with the opening of a new office in Yokohama, Japan. This office has 970 m2 (10,440 sq ft) of floor space and will enable account managers to be positioned closer to key customers and Moog to attract further outstanding professionals who wish to work in the growing Minato Mirai district to the business in Japan. Japan also serves as the headquarters for Moog's Asia Pacific operations.

Moog's Shanghai Facility

The final leg of the current expansion process is the new office and production facility in Shanghai, China which opened on March 15, 2007. The new facility, located in Pudong, features 7000 m2 (75,350 sq ft) of floor space located on a 5800 m2 (62,430 sq ft) site. It reinforces Moog's sales, engineering, application, and service capabilities and will perform repairs for a wide variety of Moog's hydraulic and electric products. The facility will also play an important role in the development of Moog's testing business by manufacturing and assembling rigs for automotive and aerospace customers in the Asia Pacific region. It will be equipped with a seismic base to enable full scale testing of test rigs.

In addition to local Chinese companies, Moog will also work together with Global customers operating in China to jointly support and service their end users' equipment located in China.

About the Author:

Gary Inwood joined Moog in January 2005 as Manager for Marketing Communications. He has worked in Japan for the past 15 years in the areas of sales marketing, marketing communications, and public relations for B2B enterprises and provided design support for the three new offices introduced in this article. He completed an MBA at the University of Queensland, Australia.

INDUSTRIAL NEWS RELEASE

MOOG RECEIVES FROST & SULLIVAN NORTH AMERICAN FLIGHT SIMULATION TECHNOLOGY INNOVATION AWARD

January 29, 2007, East Aurora, NY (NYSE: MOG.A and MOG.B) Moog today announced it received the North American Flight Simulation Technology Innovation of the Year Award (2006). The Frost & Sullivan Aerospace & Defense Group presented Moog FCS, part of the Moog Inc. Industrial Group of East Aurora, NY and Amsterdam, Netherlands, with the award for its high payload, high performance, six degrees of freedom, electric motion base system 6DOF25000E.

EXHIBITIONS, CONFERENCES & TRADESHOWS

27 - 29 MARCH , 2007
AEROSPACE TESTING EXPO 2007 EUROPE

New Munich Trade Fair Centre
Munich, Germany
http://www.aerospacetesting-expo.com/europe/
See Us at Booth #6620

16 - 20 APRIL , 2007
HANNOVER INDUSTRIAL FAIR

Hannover Fairgrounds, Hall 23
Hannover, Germany
http://www.hannovermesse.de
See Us at Booth #A23

8 - 10 MAY , 2007
AUTOMOTIVE TESTING EXPO 2007 EUROPE

Messe Stuttgart
Stuttgart, Germany
http://www.testing-expo.com/europe/index.html
See Us at Booth #4428

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For the location nearest you, visit:
www.moog.com/worldwide