

ABB IndustrialIT 800xA System in seamless tube mill

Abstract

Application of ABB IndustrialIT 800xA System in Seamless Tube Mill is described, including technological process, system configuration, software function and performance analysis etc. The automation level, productivity and control accuracy in seamless tube are extremely improved by using IndustrialIT 800xA system, stability and reliability of production are ensured as well.

1. Introduction

Today's industries request the automation control system with scalable, multi-processing capability, the ability to adapt to changes in demand, as well as openness, reliability, and maximize the availability of a higher demand. As a modern, open, scalable and based on the concept of the generalized highly efficient automation system, ABB IndustrialIT 800xA is a integrated system with a unified operation, engineering information management, high system utilization, convenience to reuse, Microsoft Windows environment, in line with the IEC 61131-3 standard programming and so on. In the practical application of seamless tube production lines, ABB IndustrialIT 800xA system solutions for the production process achieve high-performance in data acquisition, control, management and monitoring.

TPCO 258 PQF as the world's most advanced hot tube rolling mill production line is repeated successful cooperation between ABB China Metals and TPCO. ABB is a global leader in power and automation technologies in the related field, is committed to industry and power industry customers with solutions. ABB China Metals business unit, is the global ABB R&D and Center Of Excellence for seamless tube mill. With its strong technical strength, excellent performance and abundant in experiences, ABB China Metals has been maintaining a stable domestic leading position in seamless tube mill control technology and long-term holding domestic market share more than 60 percent.



2. Seamless tube mill production process description

2.1. Seamless tube mill general production process flow see Figure 1

2.2. For example, describes production process details of TPCO 258 PQF Rolling Line

The heated billet(1250~1280°É) is discharged from rotary hearth furnace to take over position with the hydraulically operated lever, and then moved one cycle on the slope of the cross transfer chain to roller conveyor, during transportation on roller conveyor, oxidize iron scale are removed.

At the end of conveyor the hydraulically operated lever kicks over billet from conveyor to Cone Type Piercer (CTP) inlet trough, entry pusher will push billet to CTP mill stand for rolling.

Cone Type Piercer mill is the most advanced mill which has two vertical rolls.

Billet piercing is the first important deformation step in the production of seamless tubes that the billet is rolled over a plug into a hollow bloom.

At the exit section of the CTP mill, Three-Roll type Guide (TRG) mandrel bar steadier provide the control of the mandrel bar with respect to the rolling axis (position stability is important for the hollow bloom concentricity). The first TRG steadier is located very close to the centerline of the mill to ensure a correct plug bar centering at the beginning of rolling process.

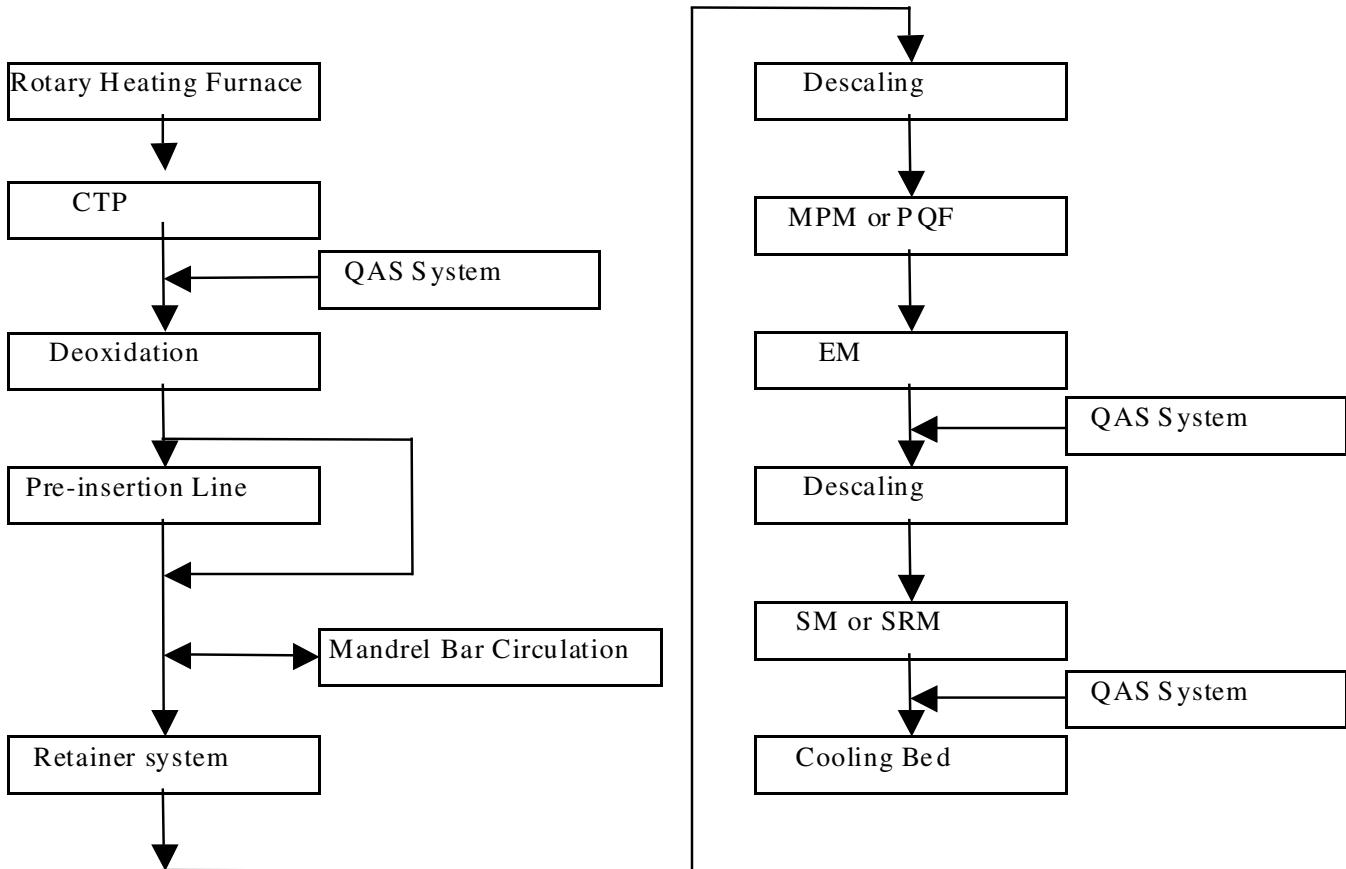
At approaching of hollow bloom, the TRG steadier are automatically opened and then closed on the hollow bloom for its better guiding during rolling.

When the piercing operation is finished, the piercer plug is retracted by the Mandrel Thrust Block (MTB), which is travelling backwards. When mandrel thrust block reaches the final retracting position, the mandrel plug is water-cooled. After each rolling cycle, the plug will be changed by an automatically operated changing device. The unit will mainly consist of a box, carrying three (3) plugs. Attached to this box is a second box, carrying three additional plugs for redundancy, to allow a quick replacement of the complete set.

Hollow bloom is transferred to turning device by take over lever, there an antioxidant powder is blown by nitrogen into the hollow bloom; the hollow bloom is then transported to the PQF rolling line by manipulator.

Mandrel insertion into the hollow bloom is performed either in-line or off-line of the PQF rolling axis; In off-line mode, the chain drive pre-inserter moves lubricated mandrel into hollow bloom, then rotary arm transports mandrel and hollow bloom together to the PQF mandrel mill inlet side; In on-line mode, rotary arm transports hollow bloom directly to PQF mandrel mill inlet side and retaining rack system inserts mandrel into hollow bloom for rolling with defined speed curve. At the PQF entry a high-pressure water system is provided for outside hollow bloom descaling.

The PQF process is based on the continuous rolling principle through 6 stands PQF(3-roll-stands) on a mandrel, which moves at constant controlled speed during the whole rolling phase.



1 Seamless tube mill general production process flow

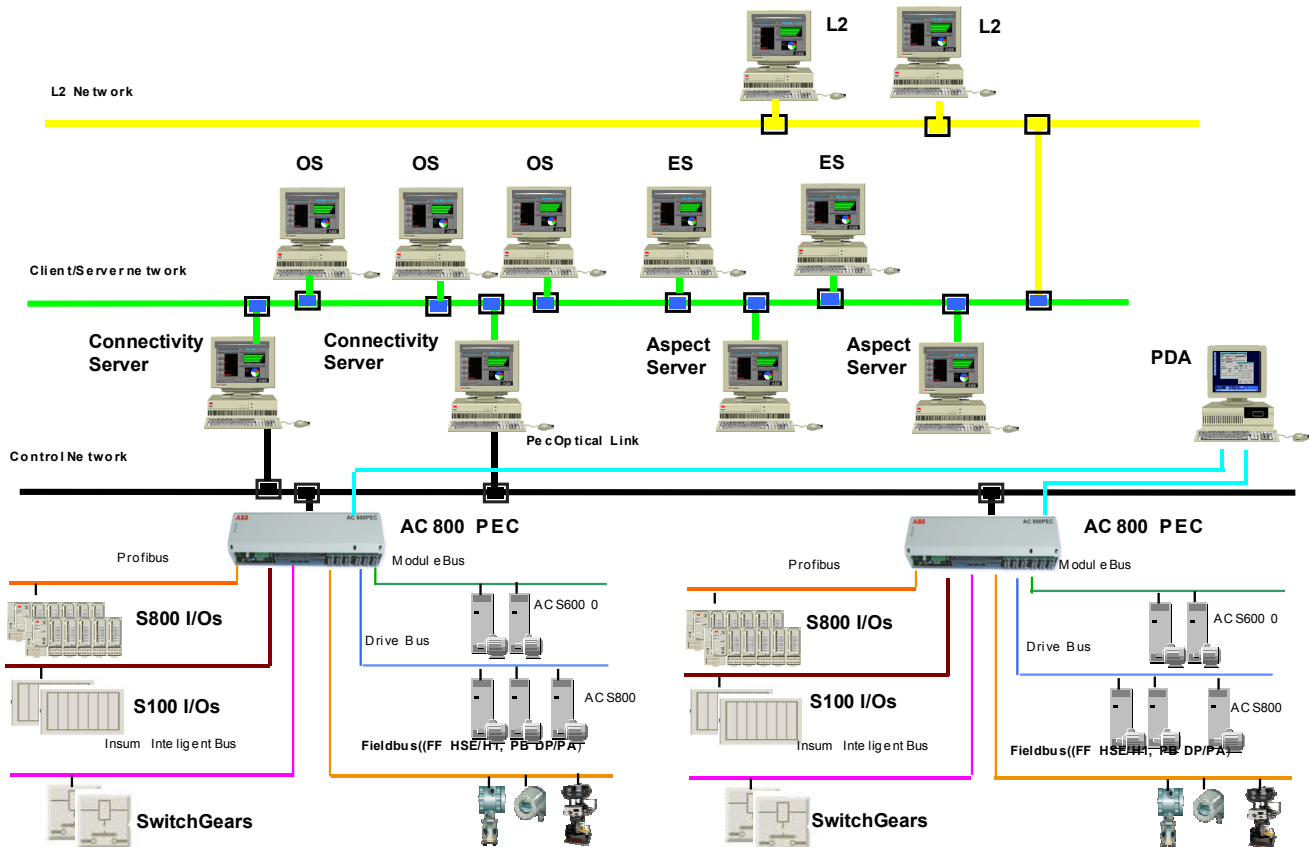
There are F191° F235 and F263mm series of pass groove, maximum exit speed up to 5.5m/s. Directly in line with the PQF, the extracting mill is installed with three 3-roll type stands. After extracting operation, the mandrel returns to the rolling starting position, discharged and conveyed to the mandrel circulation system which provides to cool and lubricate the mandrel with graphite. The maximum mandrel number in mandrel circulation system is 7.

At extracting mill exit, a wall thickness measuring device is installed, directly connected to the automatic gap control system of PQF stands. At the outlet of the extracting mill, the shell is transferred to the sizing mill, here the final rolling for the diameter size range 114.0-245.0 mm will be performed. The maximum exit speed of sizing mill is 3.5m/s. At sizing mill exit, there is a measuring device used for wall thickness, diameter and temperature. The tubes are cooled down on cooling bed, after ends cutting and cutting into lengths, the tubes will be sent to the finishing lines.

3. The network topology in application of ABB IndustrialIT 800xA system in seamless tube mill is as next in Figure 2

3.1. The basic level Control Network, it is a local area network (LAN) optimized for high performance and reliable communication, with predictable response times in real time. Controllers and Connectivity Servers are connected to the control network.

ABB AC800 PEC is high-end controller. Its CPU is using PowerPC® 750FX high-speed low-power CPU, its clock frequency is up to 600MHz. The controller has a modular design, flexible and scalable, editable cycle of multi-level priority interrupt tasks, so that the CPU load can be rational allocated to maximize performance in practical applications. The fastest code cycle time in the Control Builder layer can be 1ms; in the C-Code layer can be 100's; in VHDL layer can be 1's. In tube rolling production, according to the actual demand for device control, the program is set to deal with multi-level tasks cycle



time from 1ms to 1000ms. For instance, the rapid positioning control of retainer rack equipment is set to 2ms task cycle, and the task of rolling lot program handling uses the cycle of 1000ms. In addition to the same task cycle level, configurable starting time offset can be used to effectively reduce the CPU load and avoid the peak load.

Basic IO system is divided into local S100 IO system and S800 Remote IO system, they all support hot-swap, IO modules can be analog (0 - ± 2.5V, 0 - ± 5V, 0 - ± 10V, 0 - ± 5mA, 0 - ± 10mA, 0 - ± 20mA, 4-20mA, and the PT100 temperature measurement) and digital (24VDC, 10-30VDC, 48VDC, 110VDC, 24-220VAC) input and output, S100 DSDP170 high-speed pulse counter board can count up or down at maximum pulse frequency of 2.5MHz. These fully meet the requirement of detection and control of the various types of signals in tube mill process. The S100 IO system is mainly used for the local high real-time signals, such as emergency / quick stop signals, rapid material detection signals, and the limit position detection signals. S800 remote IO system is mainly used for the signals which more concentrated location and normal real-time requirements case, such as the console components signals.

The drive system are ABB ACS800 low voltage multi-drive system and ABB ACS6000 medium voltage multi-drive system with common DC bus-bar configuration, the advanced Direct Torque Control (DTC) technology is applied to fully satisfy requirements of the control accuracy and response time. Compact cubicle structure saves installation space significantly. Modular design concept with a fast and easy maintenance features reduce production downtime greatly. In mandrel mill inlet side, the mandrel retaining system reciprocating motion on the rolling line is obtained by a rack and pinion system which connects to 4 AC motors through gearbox. Thanks to DTC technology, rapid smooth speed control, precise positioning, and balanced distribution of torque for 4 motors can be achieved, at the same time the gear backlash caused by mechanical impact is limited effectively. The application of ACS800 drive system in the PQF main stand realizes good performance of synchronous speed control for the 3 rolls of each stand, as well as the impact speed compensation and head tail sharpening control. These functions ensure shell uniform deformation after PQF rolling mill, improve product geometry accuracy and surface quality both inside and outside.

3.2. The second level is Client / Server Network that used for communication between servers, and between client workplaces and servers.

ABB IndustrialIT 800xA System Server mainly consists of Aspect Server and the Connectivity Server, Aspect Server is generally responsible for the information, the object of management and distribution functions, such as client and server-side data synchronization, the account authority management, information redundant backup, alarm event information storage, and background service management etc. Connectivity Server is generally responsible for the real-time data acquisition and providing automatic data updates for Aspect Server. In practical applications, Connectivity Server collect data source through OPC interface from the controller and the other OPC standards. Multi-segment Connectivity server can increase the data transmission efficiency and reduce server load.

In TPCO 258 PQF tube mill project, redundant server solution was provided to ensure the reliability of the system of continuous production and avoiding mechanical damage caused by system failure.

Operator Station HMI provides a Microsoft Windows-based Human-Machine Interface and powerful functions of alarm and trend analysis. Engineer Stations based on Control Build professional software platform are used for programming and commissioning, they have off-line simulation test function. Many programming language such as Instruction List (IL), Ladder Diagram (LD), Function Block Diagram (FBD), the Structure of the Text (ST) and Sequence Function Chart (SFC) are supported. Base on the fully-fledged design, programming and commissioning experience in seamless tube mill, ABB China Metals developed a lot of tube rolling application libraries, such as drive control; Motor speed control; rapid positioning control by motor or proportional valve; proportional valve speed control; TRG Control; MTB control; mandrel plug change control; rotary arm positioning control; retaining rack system control; synchronous control of three-rolls in each main stand; impact speed compensation control; rolling lot and program handling etc. The libraries of application have significantly shortened the time for programming and site commissioning.

PDA monitoring and fault diagnosis system can collect real-time signals from AC800 PEC controller through a dedicated fiber-optic interface. The shortest sampling time is 1ms. Using PDA client / server solution, operators and electrical staff in different locations can monitor, analyze and rapidly diagnose the process information in real-time. The real-time signals acquisition such as speed, torque, current can be collected and automatic stored by user-defined format like day, week, month, events trigger etc. PDA off-line fault diagnosis can use formula to analyze collected data and printing. PDA system is also useful in preventive maintenance.

3.3. The third level L2 (production management network), is responsible for the management of production. Including order management, material tracking, production downtime management, reporting and other functions.

Production management staff sends order data to operator station through L2 or L1.5 (Gateway PC) system, operator confirm and accept order, then require rolling program data from technology computer. Production management staff gets status of order timely through L2 or L1.5 (Gateway PC) system. Material tracking system tracks material in different places of rolling line and collects the actual measured data. Each material order data, rolling lot data, the actual measured data with the material identification number together is stored in the L2 or 1.5 (Gateway PC) system database, and L2 or 1.5 (Gateway PC) systems generate reports at the same time. In production downtime management, the operator inputs causes and time in the operator station according to the shutdown conditions. The information is stored in the L2 or 1.5 of the database system, so that the production managers can monitor real-time production status and analyze production management.

4. Conclusion

ABB IndustrialIT 800xA System has been successfully applied in TPCO 258 PQF mill, which is the most advanced tube rolling mill in the world. The project commissioning started from beginning of March, 2008, and first hollow bloom was successfully rolled in CTP section on the March 28, 2008, the first tube for whole line was successfully rolled on April 25, 2008, which created a new record of seamless tube mill commissioning. At present, the TPCO 258 production line is running well, control is accurate, reliable and easy to maintain. All guaranteed values have been fully met, and with reduced energy consumption and improved productivity, the company has created a considerable social and economic benefit at same time.

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