

HollySys

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Version: Oct-2023



Intelligence For Excellence

PRODUCT BROCHURE

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Profile

Founded in 1993, HollySys is a leading supplier of intelligence solutions with more than 4,700 employees and operates in both China and abroad. HollySys is headquartered in Beijing with R&D, production, and service bases in Beijing, Hangzhou, Xi'an, Singapore, and local branches in major cities in China, as well as offices in India, Malaysia and Indonesia, establishing a comprehensive service network across the world.

HollySys business consists of industrial intelligence, transportation intelligence, and food and pharmaceutical intelligence, covering the main industries for the national economy and the people's livelihood. With years of technological accumulation in various fields and continuous capacity building, we can provide customers with customized integrated solutions, stable and reliable products, and full lifecycle services, helping them improve market competitiveness. Over the past three decades, we have served more than 35,000 clients, successfully completed more than 45,000 projects, and gained more than 1,000 new clients each year, making HollySys a world-renowned brand in automation and intelligence filed.

The HOLLIAS industrial control platform of HollySys features a series of advanced, practical and reliable industrial automation systems and HollySys automation instrumentation. The system products include MACS-K, industrial control system DCS, professional control systems such as DEH, ETS and SIS, and whole-process information-based software for manufacturing enterprises. Instrumentation products include isolated safety barriers, signal isolators, surge protectors, power transmitters, pressure transmitters, electromagnetic flowmeters, metal tube float meters, magnetic level gauges, radar level gauges, throttling elements, thermal elements, and pressure gauges.

The company's products have been successfully applied to major projects and key equipment, including 1000MW ultrasupercritical thermal power units, 1.2 million tons of urea and 5 million tons of oil refining main units, earning a good reputation in the industry.

Specializing in HollySys Instrumentation and control system engineering and integration, the company can provide both new and brown-field projects of enterprises with HollySys proprietary products, as well as comprehensive engineering services such as customized design and construction & commissioning.

HollySys has always pursued continuous innovation and R&D while sticking to its vision "create the most valuable intelligent company through stable and sustainable development" to provide more reliable, secure, and intelligent technology and products for our customers.

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Development of HollySys Turbomachinery Control Business



1991		The 1st generation Digital Electro-Hydraulic (DEH) system was introduced to turbine control. 200MW DEH was successfully put into operation.
1998		High pressure fuel resistant DEH system was introduced and successfully put into operation.
1999		5 types of DEH systems were put into operation successively. The 1st DEH related patent certificate was obtained and the application technology of DDV valve in DEH was developed.
2000	~ 2003 —	9 DEH-related patents were obtained and 300MW DEH was successfully developed.
2006		DEH was applied to integrated project of blast furnace blower driven by steam turbine.
2006		Self-contained EH servo system was introduced and applied in reconstruction of various old units.
2007		DEH for driving steam turbine was developed and successfully applied in steel, air separation and petrochemical industries.
2008		Turbine controller was introduced and widely used on compact units.
2009		Electric regulation technology was successfully applied to TRT control system of blast furnace residual pressure power generation.
2010		HollySys DEH was successfully applied to 600MW Supercritical units.
2011		HollySys MEH was successfully applied to 1000MW Ultra-supercritical units.
2011		T810 Compressor Control System (CCS) based on DCS platform was developed with speed regulation and surge control.
2012		DEH was applied to 1000MW nuclear unit.
2012		SIL3 certificate for HollySys Safety Instrumented System (SIS) was accredited by TÜV Rheinland, and T880 CCS based on SIS triplicated hardware was introduced.
2016		Patent registration for compressor control algorithm was completed.
2019		Compressor control algorithm was upgraded to include compressor simulation model and surge inspection model.
Now		2000+ CCS projects were completed, 26 patents were obtained, and rich control technology and engineering experience was accumulated

Compressor Control System (CCS) Overview

HollySys provides customers with entire factory automation solutions. As an important part of the intelligent plant, CCS is an important breakthrough in energy conservation and emission reduction and carbon dioxide emission reduction in the overall industrial process. Realizing the whole process energy conservation and emission reduction and intelligent control can bring huge benefits to enterprise users.



HollySys Control System Product Family

HollySys compressor control technology and solutions are based on generator unit control technology and high reliability redundant system software and hardware platform, adopting international advanced compressor control algorithm to ensure safe and efficient operation of the whole unit, freeing the hands of operators and achieving a full automation solution with high efficiency and energy conservation.

The compressor anti-surge control algorithm is based on an independent coordinate system to realize the automatic adaptive compensation of the surge line of the unit under different compressor inlet working conditions, solve the problems of distortion of the surge line caused by the mismatch between the compressor design working conditions and the actual operating conditions, and create a prerequisite for the efficient operation of the unit. At the same time, through the dynamic decoupling algorithm between performance and anti-surge loop, multi-section anti-surge loop, the compressor can be started and stopped with one key, and the compressor can be fully loaded and unloaded. The control strategy can perfectly adapt to the complex process under the condition of ensuring the safe operation of the unit.

The multi-unit series parallel control scheme breaks through the traditional single unit control strategy. While considering the single-unit control, the coordination controller between compressor groups is introduced to coordinate the distribution of the load of each unit, so that each unit can work under the optimal load state, greatly improving the efficiency of the compressor group, and realizing the fully automated coordinated management of the compressor group.



Compressor Hardware Platform

HollySys provides a variety of control product platforms for compressor control solutions (CCS), from conventional redundant control systems (T810) to triple redundant fault tolerance systems (T880) with SIL3 certification, providing users with a wide range of product choices and enabling them to obtain cost-effective compressor control applications.



HOLLiAS Compressor Control System Architecture

T880 Triplex Compressor Control System

T880 System Overview

T880 system is a turbine compressor integrated control system CCS (Compressor Control System) developed on HOLLiAS HiaGuard safety instrument system platform. The system has passed the TÜV (Rheinland Industrie Service GmbH) certification and meets the SC3 system capability level and SIL3 safety integrity level defined in IEC 61508/IEC 61511.

The system is fully integrated with the design concept of triplex, meet the requirements of real-time, high reliability and stability of critical field equipment, and integrating a dedicated compressor control software package, including anti-surge control, performance control, speed control, etc.



Highlights & Features of T880 System



High Safety

- · Adopting 2003D architecture to guarantee system safety.
- · Adopting multiple voting in data flow.
- Triple redundant design to ensure physical independence and avoid common cause failure.
- High coverage of self-diagnosis.
- Communication modules with build-in firewall for cyber security.



Powerful SOE Function

- · DI module with build-in SOE function.
- DI module supports cache for up to 1000 SOE records.
- FCS supports to store up to 10000 SOE records.
- SOE accuracy up to 1ms.

High Availability

- · 3-2-0 degradation.
- · Independent power supply for system power and field power.
- · 1+1 redundant power supply.
- Communication module and IO modules support redundant configuration and bumpless switching.
- System availability up to 99.999%





Seamless System Integration

- · Supporting seamless integration with HOLLIAS-MACS System.
- Supporting integration with 3rd DCS via Modbus interface.



High Coverage Diagnosis

- · Channel level fault diagnosis.
- · AI channel supports diagnosis for over range, open circuit, short circuit, ect.
- · AO channel supports diagnosis for open circuit, read-back and others.
- DI channel supports diagnosis for grounding, disconnection, short circuit and others.
- DO channel supports diagnosis for no-load, overload, read-back, short circuit and others.
- · PI channel supports diagnosis for disconnection, out of lower limit, etc.



Scalable System Scale

- Single station contains 1 main rack + 6 extension racks, up to 1856 IOs.
- Max 15 domains in a system and single domain supports max 64 stations.



T880 System Architecture

Hardware Structure

T880 system is based on triplex (TMR) and hardware fault-tolerant safety control technology, and is used in various complex and dangerous production processes to perform real-time control, receive field signals, perform logic operations, output control signals, drive field actuators, etc.

T880 system consists of engineer station and safety control station:

The configuration software Safe-AT on the engineering station is a T3 tool certified by IEC 61508 SC3.

The control station is composed of controller modules, I/O modules and their terminal boards, and network communication modules meeting the requirements of IEC61508 SIL3. The rack of the system is divided into main rack and expansion/remote racks, and the main rack and expansion/remote rack are connected through repeater/optical fiber. The field instruments are connected to the I/O module through the terminal board and DB cable.

The system structure from input module, controller to output module is completely triple redundant. The triple controllers adopt three controller modules for independent configuration and synchronous operation. Triple I/O channels are built in each I/O module. Single configured I/O modules can meet the requirements of IEC 61508 SIL3. I/O modules can be configured redundance to enhance availability. The system controller and I/O modules have a variety of fault diagnosis and corresponding fault handling realized through software and hardware, which ensure the system safety integrity level. The 1+1 redundant and isolated system power supply and field power supply as well as the input/output modules and communication modules support redundant configuration, which improves the high availability of the system.

Network Architecture

T880 system includes engineering station, operator station, historian station, control station and other components, forming the system network and control network. The control network nodes are the control station and I/O module. The T880 system supports 15 domains, each domain supports 64 control stations, a single station supports up to 1856 I/O points, and the main rack supports 224 I/O points.









T880 Hardware Overview

The hardware of T880 system includes racks, power modules, controllers, communication modules, relay modules, optical fiber modules, input/output modules, etc.

Product	Model	Description
Deele	SGM101	Main rack
Каск	SGM110	Expansion rack
	QS10.241	Plus 240W power supply
Device Commbr	QS20.241	Plus 480W power supply
Power Supply	PRO MAX 240W 24V 10A	Weidmuller 240W power supply
	PRO MAX 480W 24V 20A	Weidmuller 480W power supply
PRO MAX 480W 24V 20A Controller SGM201 SGM210 SGM220		Controller
	SGM210	Communication module
	SGM220	Remote I/O communication module (multi-mode FO)
Communication	SGM221	Remote I/O communication module (3 ports single mode FO)
Module	SGM222	Remote I/O communication module (single port single mode FO)
	SGM230	Modbus communication module
	SGM240	IO communication repeater module
	SGM410	16-channel AI module
SGM210 Communication module SGM220 Remote I/O communication module (multi-model) SGM221 Remote I/O communication module (3 ports single) SGM222 Remote I/O communication module (single port state) SGM230 Modbus communication module SGM240 IO communication repeater module SGM240 IO communication repeater module SGM520 8-channel AI module SGM520 8-channel AO module SGM610 32-channel DI module SGM633 Pulse and over-speed module SGM710 32-channel AI terminal board	8-channel AO module	
	32-channel DI module	
	Pulse and over-speed module	
	SGM710	32-channel DO module
	SGM3410	16-channel AI terminal board
	SGM3520	8-channel AO terminal board
I/O Terminal Board	SGM3610	32-channel DI terminal board
	SGM3633	Pulse and over-speed terminal board
	SGM3710	32-channel DO terminal module

T880 System Software

Engineering Software

Safe-AutoThink (hereinafter referred to as Safe-AT) is a configuration software independently developed by HollySys for the industrial safety instrument system (hereinafter referred to as SIS), which is part of the control logic configuration software of the T880 system. The software has passed the TÜV Rheinland certification and fully meets the requirements of IEC61508 for T3 tools of SIL3 system.

Project basic information configuration
Hardware configuration
· Logic programming
· Compiling and downloading
· Simulation
· Force value
· SOE view
Controller running status monitoring
• Safe AT provides a variety of programming languages that meet the requirements of IEC61131-3 standard, through which the logic scheme can be realized.
· Ladder diagram (LD)
• Function block diagram (FBD)
Structured text (ST)

HMI Software

The system HMI software is based on HOLLiAS MACS V6 HMI platform and runs on the operator station. MACS V6 is an HMI monitoring software developed based on Microsoft Windows operating system. It runs on the platform of Windows XP/Windows 7/Windows 10, collects data in the controller through network communication, and dynamically displays production data by using the powerful graphic function. The HMI software of operator station is the most direct and important human-computer interaction interface, which supports dedicated industrial keyboard, printer and other external devices. The tasks included in the software mainly include flow chart, alarm, log, report, overview, trend, control group, parameter group, process control, system management and other functions.

MACS V6 has powerful and rich functions, including: data acquisition, process control, alarm, trend, overview, simulation flow chart, data list, log management, table management, event sequence record, report and data statistics, display management, man-machine conversation, printing management, system fault diagnosis and monitoring, system configuration, OPS online parameter setting, offline query of archived data, control group, control loop, etc.







T810 Compressor Control System

T810 System Overview

T810 compressor control system is a product platform developed based on HollySys HOLLiAS MACS-K system and dedicated to the control of rotary compressor units. T810 system adopts a fully redundant and fault-tolerant architecture, and integrates professional compressor control software packages, including anti-surge control, performance control, speed control, etc.



Highlights & Features of T810 System

Reliability

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Full Redundancy:

System network, control network, controller, power supply and IO modules all support redundant configuration.

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Rich Diagnosis:

Controllers and IO modules are designed with intelligent diagnosis function. Each module has self-diagnosis and fault report function on communication, signal disconnection, short circuit, over range and so on.

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Multiple Isolation:

Optical isolation between bus and modules; isolation between system power and field power; faulty channel isolation.

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Reliable Design:

Adapts to complex industrial environment, complies with IEC61000 anti-corrosion capacity, and meets the requirements of ISA S71.04 standard G3 level. The reliability meets the certification requirements of China Classification Society.

Safety

- Secure network: The system network adopts deterministic real-time Ethernet and is equipped with a firewall switch; the controller adopts industrial chip, with built-in anti-network storm components.
- Adopts safety system design concepts, such as signal quality level judgment and fault oriented safety, to improve system reliability. Support hot plug, and the enhanced base provides 220 VAC channel protection.
- Fail safe: The whole system follows the safety design concept. The signal quality is verified before calculation. In case of failure, the output can automatically switch to the preset safety value.

Advantages

Intelligent Configuration:

such as configuration wizard function, automatic generation of system cross reference information, etc.

Open Platform

- Supports OPC interface, open network architecture (Supports ODBC), and can provides web interface.
- Supports P-to-p, C/S and hybrid network structure. Supports the industrial Ethernet connection of star, ring or bus topology.
- Compatible with various field buses, supports HART, PROFIBUS DP, PROFIBUS PA, MODBUS, etc.
- Rich HMI function, conforms to IEC61131-3 requirement for control algorithm programming software.
- Supports users to customize various function blocks and script languages.
- The control algorithm and hardware configuration can be flexibly modified, and can be installed without disturbance without stopping field device.
- Easy maintenance and replacement; provides complete system status and diagnostic information.



Cyber Security: Multiple cyber security measures are adopted, including industrial security gateway, firewall, intrusion detection system, network audit system, log audit system, white list, host reinforcement, industrial security management platform and so on. Information security is provided for the main controller and upper computer configuration software from aspects of identity authentication, access control, security audit, communication integrity, communication confidentiality, software fault tolerance, resource control, etc.

Advanced Functions:

such as numerous advanced control modules, special control modules, system function call interfaces, etc.



T810 System Architecture

Based on the industrial Ethernet and PROFIBUS-DP field bus, T810 integrates the HART-based standard protocol to uniformly manage the field intelligent devices, and can easily integrate SIS, PLC, MES, ERP and other systems, so that the information between the field intelligent instrument equipment, control system, and enterprise resource management system can be seamlessly transmitted, realizing factory intelligence and integration of management and control.

T810 system includes engineering station, operator station, historian station, control station and other components. The network architecture is composed of three layers from top to bottom: management network (MNET), system network (SNET) and control network (CNET). The network node of control network includes control station and I/O module.



System Architecture

T810 Hardware Overview

The hardware of T810 system includes power supply, backplane, controllers, communication modules, relay modules, I/O modules, bases, etc.

Product	Model	Description	
	K-CU02	Controller module, supports 50ms refresh cycle time	
Product Model Description Controller K: CU02 Controller module, supports 50ms refresh cycle time K: CU11 Controller module, big capacity, trustable K: CU03 High-performance controller backplate for K:-CU01/02/11 K: CU13 High-performance controller backplate for K:-CU03 K: CU13 High-performance controller backplate for K:-CU03 K: K: CU13 High-performance controller backplate K: K: CU13 Bus IO-BUS module K: K: K: SU10 Single siot IO-BUS module K: K: SU11 B: channel high-performance Al module, optional redundant K: All01 B: channel high-performance Al module, optional redundant K: All02 S: channel high-performance Al module, optional redundant K: All03 B: channel AD module, optional redundant K: All03 B: channel AD module, optional redundant K: All03 B: channel AD module, optional redundant K: All04 B: channel AD module, optio			
		K-CUT01	4-slot controller backplate for K-CU01/02/11
Controller Backplane	K-CUT03	High-performance controller backplate for K-CU03	
	K-BUS02	8-channel star IO-BUS module	
	K-BUS03	Bus IO-BUS module	
IO-BUS Module	K-BUS04	4-channel high-speed IO-BUS module	
	K-BUST01	Single-slot IO-BUS backplane	
	K-BUST02	IO-BUS terminator for star type topology	
	K-AI01	8-channel AI module, optional redundant	
	K-AIH01	8-channel AI module with HART, optional redundant	
	K-AI02	8-channel high-performance AI module, optional redundant	
AI Module	K-AIH02	8-channel high-performance AI module with HART, optional redundant	
	K-AI03	16-channel high-performance AI module, optional redundant	
	K-AIH03	16-channel high-performance AI module with HART, optional redundant	
	K-AI04	8-channel high-speed Al module	
	K-A001	8-channel AO module, optional redundant	
AO Module	K-AOH01	8-channel AO module with HART, optional redundant	
RTD Module	K-RTD01	8-channel RTD module, optional redundant	
TC Module K-TC01 8-channel TC & MV input module, optional redundant		8-channel TC & MV input module, optional redundant	
	K-DI01	16-channel 24VDC DI module, optional redundant	
Action Action Controller K-C002 Controller module, supports 50ms refresh cycle time K-C003 High-performance controller module, supports 10ms cycle time K-C003 High-performance controller backplate for K-C003 K-C004 K-C003 High-performance controller backplate for K-C003 K-BUS04 & channel star 10 BUS module K-BUS04 K-BUS04 & channel high-speed 10-BUS module K-BUS04 K-BUS02 IO-BUS to IO-BUS the Star ID BUS module K-BUS04 K-BUS02 IO-BUS terminator for star type topology K-BUS04 K-AI101 8-channel Al module, optional redundant K-AI102 K-AI102 8-channel high-performance Al module, optional redundant K-AI102 K-AI103 16-channel high-performance Al module, optional redundant K-AI103 K-AI104 8-channel high-performance Al module, optional redundant K-AI104 K-AI103 16-channel Al module, optional redundant K-AI104 K-AI104 8-channel AD module, optional redundant K-AI104 K-AI104 8-channel AD module, optional redundant K-AI104 K-AI103 16-c	16-channel 48VDC DI module, optional redundant		
	DI Module	K-DI13	Description Controller module, supports 50ms refresh cycle time Controller module, big capacity, trustable High-performance controller module, supports 10ms cycle time 4-slot controller backplate for K-CU01/02/11 High-performance controller backplate for K-CU03 8-channel star 10-BUS module Bus 10-BUS module 4-channel high-speed 10-BUS module Single-slot 10-BUS backplane 10-BUS terminator for star type topology 8-channel AI module, optional redundant 8-channel high-performance AI module, optional redundant 8-channel high-performance AI module, optional redundant 16-channel high-performance AI module with HART, optional redundant 16-channel high-speed AI module 8-channel high-speed AI module 8-channel AO module, optional redundant 8-channel AD module, optional redundant 16-channel AVDC DI module, optional redundant 16-channel 24VDC DI module, optional redundant 16-channel 48VD
Controller K-CUI1 Controller module, big capacity, trustable K-CUI0 High-performance controller module, supports 10ms sycle time Controller Backplane K-CUI0 4-alot controller backplate for K-CU03 K-CUI0 K-BUS02 8-channel star 10-BUS module K-BUS03 Bus 10-BUS module K-BUS03 K-BUS04 4-channel high-speed IO-BUS module K-BUS03 K-BUS01 Single-slot 10-BUS backplane K-BUS01 K-BUS10 Single-slot 10-BUS backplane K-BUS10 K-AH01 B-channel high-speed IO-BUS module K-BUS10 K-AH02 B-channel high-performance AI module, optional redundant K-AH01 K-AH03 16-channel high-performance AI module, optional redundant K-AH03 K-AH03 16-channel high-performance AI module, optional redundant K-AH03 K-AH04 B-channel AD module, optional redundant K-AH03 K-AD04 R-channel AD module, optional redundant K-A104 K-AD01 B-channel AD module, optional redundant K-A103 K-AD01 B-channel AD module, optional redundant K-A104 K-AD01			
	K-DI12	16-channel 48VDC high-speed DI module, optional redundant (exceptional for SOE function)	
	K-SOE01	16-channel 24VDC SOE input module	
SOE Module	K-SOE11	16-channel 48VDC SOE input module	
	K-D001	16-channel 24VDC DO module, optional redundant	
DO Module	K-D002	16-channel 24VDC high-speed DO module	
Speed Module	K-FC01	Turbine speed module	
Servo Module	K-SV01	Turbine servo module	
Speed Controller	TC50R	Turbine speed controller	
Anti-surge Controller	CC50R	Anti-surge controller	



T810 Software Overview

MACS V6 software is an integrated industrial automation control system software developed by HollySys. It is an open software platform that can provide professional configuration solutions according to the automation control requirements of different industries.



MACS V6.5.X Software System Architecture





MACS V6 Software Architecture

The major components of MACS V6 include:

System Configuration Management Software

The configuration software is used for configuring, deploying and managing the entire DCS system, undertaking the major configuration work, and completing compilation, downloading, project management, and other functions.

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Controller Programming Software

It is used for realizing the functions of onsite signal acquisition, engineering unit transformation, control and interlocking control algorithm, control output, and transmitting data and diagnostic results to the operator station through the system network. It supports four programming languages: ST, SFC, CFC, LD following IEC61131-3 standard.





Online Monitoring Software

The monitoring software is oriented to the operator. It provides data for the users in the form of simulation flow chart, bar chart, numerical table, trend curve, report, button, dialog box, etc., executes the operation instructions and sends them to the field control station. It conducts real-time data acquisition, dynamic data display, process automatic control, sequence control, advanced control, alarm and log detection, monitoring, operation, and data recording, statistics, display, printing, etc.

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Auxiliary Software

It is used for realizing the auxiliary configuration, system query, management function and offline simulation functions of T810 system. The system configuration management software is installed on the engineering station. It is an integrated configuration tool and modular software. Each module is integrated through COM technology, and its functions can be expanded through plug-in.

Compressor Control Solution

HollySys provides a comprehensive compressor control solution (CCS): for both fixed speed compressor and variable speed compressor, from the anti-surge controller for controlling and protecting the compressor to the performance controller for process operation. It helps users realize safe and efficient operation of rotating machinery and equipment, and achieves smooth operation and optimized operation of the whole process from start-up to normal production. The control solutions of compressor are shown as follows:

Protection

Electric overspeed trip	0
Overspeed avoidance	S
Overacceleration trip	S
External ESD trip	G

Test Function

· Trip test

Electric overspeed test



Compressor control solutions

Turbine Speed Control

The major functions of turbine speed controller as below:

Speed Control

- · Open loop startup and surge back
- Warm up/down
- Semi automatic warming up/down

- Manual control
- Remote/local speed control
- Shutdown

The turbine speed controller can realize the complete auto startup process. The open-loop starting mode is adopted from the starting. When the speed is established, the auto surge-back control and starting protection strategy realize the safe and stable starting process of the compressor, and avoid the major accident caused by the speed probe failure. During turbine speed up, manual and automatic switching can be flexibly carried out when the turbine is in the non-critical area. In the critical area, the speed is increased adaptively and quickly. When the speed is increased at a large rate out of the critical area, the system automatically brakes to avoid serious overshoot and consequent big speed fluctuations, so that the turbine speed smoothly increases from a rapid rise rate to a normal rise rate. The comprehensive protection and control measures of the speed controller guarantee the entire compressor table and efficient operation.





Operator command trip afety fault trip hutdown manual misoperation trip

Governor stall trip

· Mechanic overspeed test



 H_{p}

100

80

60

40

2000 400

Compressor Anti-surge Control and Protection

WM=28

WM=122

 Q_s (ACMH)

→ WM=6.3
• WM=4.2

6000 8000

Correlation Coordinate System

HollySys compressor control solution adopts advanced mathematical calculation method based on independent coordinate system, which ensure the calculation of compressor surge limit line independent from inlet working conditions (MW, Ps, Ts, ks, Zs), thus fundamentally ensuring the dynamic operation performance of compressor unit under variable working conditions.

hr

0.04

0.03

0.02

0.01

0.02 0.04

Independent Coordinate System

WM=28

WM=122

WM=6.3

WM=4.2

0.06 0.08

Anti-surge main PI response Adaptive differential response (surge control margin) Emergency surge response (with first-order delay detection time) Differential control response Inlet pressure low limit control Inlet pressure high limit control

Compressor anti-surge control includes:



It has nothing to do with the molecular weight MW, the inlet working conditions (Ps, Ts, ks, Zs), or the transmitter range and unit. It only relates to the ratio of signals of the same type, and the ratio is dimensionless. It requires signals from five tags: Δ Pos, Ps, Pd, Ts, Td.

The anti-surge controller has three operation modes: auto, soft manual and hard manual to meet the control requirements under different operating conditions. The three control modes can be switched without disturbance.

Auto mode: The anti-surge controller automatically detects the distance and position relation between the operating point and each control line, so as to automatically carry out necessary anti-surge control and protection actions.

Soft manual mode: The operator can manually position the opening of anti-surge valve for manual adjustment of process parameters. In the soft manual mode, when the operating point reaches the valve fast opening limit FOL, the anti-surge controller automatically switches from manual mode to auto mode to ensure the safe and stable operation of the compressor.

Hard manual mode: The anti-surge controller is always in manual mode, regardless of the operating point. Hard manual operation is equivalent to completely removing the anti-surge control and protection functions. The hard manual operation is automatically triggered when the anti-surge controller detects a transmitter failure and performs output freezing. Output freezing has become the most widely used transmitter failure retreat strategy in engineering applications, which maximizes the smooth and continuous operation of the process and avoids unnecessary device downtime due to transmitter failure.



- Decouping of anti-surge controller and performance controller
- Decouping of anti-surge controller and anti-surge controller
- The anti-surge valves sharing technology for multistage compressor anti-surge controllers
- Application of anti-surge control for side flow compressor
- Application of anti-surge control for parallel running compressors

Inlet Pressure Low Limit Control

When there is a fractionating tower at the upstream of the compressor, the tower pressure cannot be lower than a certain level. If it is lower than a certain level, it will cause the internal oscillation of the fractionating device with gas-liquid twophase heat and mass transfer, and then cause the oscillation of the tower pressure. When the regulation measures of the main performance controller used to regulate the tower pressure reaches the limit state, the limit control loop embedded in the anti-surge controller can be configured as the low limit of the inlet pressure. When the limit conditions are triggered, it automatically increases the opening of the anti-surge valve so as to maintain the tower pressure within an acceptable range and ensure the smooth production.



Inlet Pressure Process Flow Diagram

Application of Anti-surge Control for Side Flow Compressor

Reactive side stream application: Due to the limitation of primary conversion rate, a large number of unreacted feed gas participating in the reaction needs to be recycled continuously, and the circulation ratio is determined by the primary conversion rate.

Refrigeration type side stream application: in order to prevent reverse decomposition reaction or polymerization reaction of reaction products, it is necessary to cool the high-temperature and high-pressure reaction gas flowing out of the reactor, or provide a low-temperature cold source for the low-temperature purification/liquefaction process flow.



Inlet Pressure High Limit Control

A safety valve is usually installed at the outlet of the compressor to prevent the process flow after the compressor outlet from damage or even explosion due to the sudden and rapid rise of flow resistance and consequential overpressure in process vessels and pipelines. The safety valve trip can quickly relieve the pressure, but it usually causes shutdown. The limit control loop embedded in the anti-surge controller can be configured as the high limit control of outlet pressure. Through engineering configuration, when the outlet pressure is higher than a certain value, even if the operating point is far from the surge control limit SCL, the outlet pressure high limit control loop automatically adjusts the opening of the anti-surge valve, so that the outlet pressure is kept below the high limit value of the pressure.

Safe Operation and Countercurrent Protection

Countercurrent is the most dangerous operating condition of axial flow blower. In normal operation, if continuous countercurrent occurs and effective protection cannot be carried out in the shortest time, serious equipment damage will be caused. Reliable countercurrent protection action is a very important control function of the blower control system. The countercurrent protection functions and actions in HollySys control system include the following 3 types:

- counter increases by 1, and the anti-surge vent valve is opened by the anti-surge PID control.
- T2 time, the blower enters the "safe operation" mode, the anti-surge vent valve is quickly fully opened, the outlet check valve is forcibly closed, and the static blade returns to the minimum adjustment angle, and the "safe operation" and "countercurrent" audible and visual alarms are sent at the same time.
- After entering the "safe operation" mode, if the counter current signal still exists after T3 time, the system will execute the emergency interlock shutdown.



When the low flow condition is detected, the control system sends out an audible and visual alarm of "surge", the surge

When the countercurrent condition is detected and lasts for T1 time, or the second countercurrent signal occurs within



Process-oriented Performance Control

The performance control loop oriented to process operation ensures that the main process parameters are always near the set value through cascade control with the turbine speed controller, or direct control of the guide vanes or stationary vanes in motor drive applications. The main process parameters can be: pressure, pressure ratio, volume flow, and mass flow.

The performance controller (PIC), speed controller (SIC) and anti-surge controller (UIC) coordinate during the start-up phase of the process, so that the process can reach the minimum operating conditions of the process in a stable slope manner. And then from the minimum operating conditions to the normal production load condition following requirement from process operators. Close multi-loop coordination control is carried out among the three main control loops to ensure the stability of process operation, even when the anti-surge controller performs surge control and protection actions.

The performance controller can also provide the limit control function for the process and equipment operation limit, so as to ensure the equipment running within the acceptable process limit. For example, in motor drive applications, when the motor current reaches the maximum value, the limit control loop will reduce the process regulating valve opening, thus automatically reduces the process load and motor current.

In the application of compressor performance control, coordinated control of multiple control loops is necessary. In motor drive applications, at least one anti-surge controller and one performance controller exist. At least one anti-surge controller, one performance controller and one speed controller are used in the turbine driving application. In many technological processes, due to the application of high pressure ratio and multi-stage compressor, multiple anti-surge controllers will be used to protect the multi-stage compressor. In addition, necessary limit control loops will also be used according to the actual process application for protection of other process equipment and avoiding potential process equipment operation risks.

Among all these control loops, the relevant control loops will be affected due to the change of a control loop. For example, when the anti-surge controller opens the return valve to prevent the occurrence of surge, it will inevitably cause changes in the compressor outlet pressure, inlet pressure and flow, and deviation of process operating parameters.

By adding a decoupling algorithm between the process related controllers, the related controllers affected by the correlation are compensated in the same direction when the output of one control loop changes, so as to minimize the mutual influence between the related loops and the timeliness of control.

➡ Load Distribution and Optimal Control of Multiple Compressors



In the petrochemical, natural gas transmission pipeline and biological fermentation industries, a single compressor can no longer meet the demand for gas load after process capacity expansion. Usually, multiple compressors operate in parallel to supply gas to the process pipe network. For the application of parallel operation of multiple compressors, the single unit control mode is adopted at present, which completely depends on the experience of operators, and lacks the coordinated control of parallel load of multiple compressors. As a result, there are practical problems such as extreme high output pressure, frequent loading and venting, poor coordination of multiple compressors, information dispersion, inconvenient management, and complex maintenance. At the same time, due to the different manufacturers and performance of parallel compressors, the used control systems are also different. In particular, the control system of international compressor manufacturers is not open, which makes users rely on compressor manufacturers' technical products and services with very high cost.



The HollySys multi-compressor coordinate control system adopts the algorithm of equidistant load distribution and load balance, that is, the relative load of each unit is equal, realizing automatic one button startup, automatic loading, automatic load distribution and automatic coordinated control of the air volume of the compressor group. As shown in the figure above, taking three parallel centrifugal compressors as an example, the UCS (Unit Control System) realizes full automatic control of a single compressor and it also receives the MCS (Mater Control System) load distribution control system signal



Automatic Operation Track Diagram of Load Distribution



Schematic Diagram of Load Distribution Control

The UCS realizes the full automatic control of a single compressor. Whether it is a gas turbine driven compressor, a steam turbine compressor or a motor driven compressor, the UCS system realizes the full automatic control of a single unit. After the startup command issued, the unit automatically realizes startup, loading and automatic load regulation, and automatically realizes grid connection regulation control. It receives the command from the main load distribution control system, and automatically realizes grid connection.

The MCS is mainly responsible for the coordinated control of the parallel compressors. As the overall unit manager, the MCS system can realize load distribution for units of different manufacturers, different models and different powers. When the load is reduced, all compressors can operate at low limit; when the set value of header pressure changes, all compressors act at the same time to reach the target set value with the fastest response.

The load distribution control system is the most important part in the multi-compressors parallel control. The system will adjust the load balance between each unit according to the real-time load condition of each compressor, compressor performance and other conditions to ensure that each compressor has equal relative load. As shown in the above schematic diagram, the load distribution control system mainly includes the master load regulating controller and the load balancing controller. The master load controller controls the stability of the process parameters of the main pipe. The load balancing controllers ensure the relative load balance of the compressor by fine-tuning the inlet guide vane or speed and other parameters. The load balancing signal is superimposed on the signal output by the master performance controller. Finally, the load regulation of parallel compressors with equal distance (equal distance from the operating point to the control line) is realized. In addition, the MCS also includes the master performance override control to automatically adjust the anti-surge control of each compressor in case of sudden changes under large process loads, and advance override control to ensure that the entire compressors can quickly reach stable process parameters and avoid unnecessary shutdown.





Appendix: Typical Reference

➡ Reference in Iron and Steel Blast Furnace **Blower, BPRT and SHRT**

⊟ Reference in Petrochemical





⊟ Reference in Coal Chemical

合成气机组气路

➡ Reference in Large Steam & Electricity **Dual Drive Compressor Project**









□ Reference in Nitric Acid Unit









