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Research Article

Research on OPC-based Fracturing Unit Control System

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Abstract: With the large-scale integration of fracturing unit's on-site construction, traditional industrial buses are increasingly unable to meet the requirements for the quantity transmission between various equipment in large-scale fracturing units, and different models of different equipment manufacturers cannot cooperate with each other as there are "Islands of information" in the control system. This article uses industrial Ethernet as the physical medium for data transmission. In addition, different equipment manufacturers use OPC as the core technology of the fracturing unit control system network, and set up an intelligent fracturing unit control system, so that the control network can quickly, accurately, and safely control the fracturing truck control system. The sand truck control system monitors and analyzes, saves, and prints the construction data in the vehicle instrument. At the same time, the network control system uses the vehicle instrument as the core of the network. It can control fracturing vehicles from different manufacturers. The sand mixer truck performs network control, which effectively avoids incompatibilities between various equipment manufacturers at the construction site.

Keywords: OPC; Ethernet; Control system; Fracturing unit

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1 Introduction

The development of China's fracturing equipment has all been imported to the introduction of key technologies in terms of conversion and absorption. At present, the level of fracturing equipment in China has reached the international synchronized level. With the large-scale integration of the fracturing unit's on-site construction, the degree of data sharing between equipment is increasing, and the degree of data control and data transmission between equipment also increases. The traditional industrial bus will be replaced by a large amount of data. Therefore, the traditional industrial bus is increasingly unable to meet the requirements for the quantity transmission between various equipment in a large-scale fracturing unit, and different models of different equipment manufacturers cannot cooperate with each other. The existence of "Islands of information" in the control system makes it more difficult to configure vehicle models on the construction site, and fracturing units of the same brand must be used[1]. Therefore, developing a fracturing unit control system that is more accurate, fast, safe, stable, and compatible is an inevitable trend for the development of petroleum fracturing equipment.

2 Introduction to OPC

In industrial production, various computer systems have been widely used in different control fields, and the petroleum industry is no exception. However, in the long run, different on-site control devices used in different fracturing equipment prevents effective communication between the equipment.

OPC is Object Linking and Embedding (OLE) for process control, which provides a channel for data interaction between Windows-based applications and field devices.

OPC—usually adopts C / S (Client / Server) working mode. The data access specification mainly stipulates two parts: OPC server and OPC client. One OPC client can connect to one or more OPC servers, and multiple OPC clients can also connect to the same OPC server

at the same time; different equipment manufacturers only need to provide their devices with a server that complies with OPC data access specifications (that is, OPC data access server), other applications can access the OPC server through the OPC interface to read and write device data.

With the rise of OPC technology, each equipment control system supplier has provided its own OPC server software to facilitate the respective equipment to maximize data sharing in the network. In oil fracturing equipment, two controllers are mainly Rockwell and Siemens. The OPC server software provided by the two companies is Rockwell's NetLinx and Siemens' SIMATIC NET.

Therefore, the fracturing unit control system based on OPC technology plays an important role in implementing a monitoring system that is compatible with a variety of fieldbuses, convenient to upgrade, good in function expansion capability, strong in modularity, and capable of remote access[2].

3 Composition of fracturing unit control system

When fracturing oil field operations, a fracturing unit usually consists of multiple fracturing trucks, sand mixer trucks, vehicle instrument, manifolds and other auxiliary equipment. After the sand mixer truck uniformly mixes various additives such as fracturing fluid and proppant, it is distributed to multiple fracturing trucks through the low-pressure manifold. The fracturing truck pressurizes the mixed liquid and collects it through the high-pressure manifold to the well. Injecting high pressure and large displacement fracturing fluid into the oil and water layers creates artificial fractures. Inject the mixed liquid with proppant (such as sand) into the fractures to support the fractures that have been formed and improve the permeability of the formation near the bottom of the well. In the above process, the vehicle instrument collects, displays, and records the entire process data in real time, and centrally control several pump trucks, and finally analyze and process the fracturing operation data.

In the above-mentioned complete fracturing equipment composition, the fracturing unit control system network composition is mainly divided into a management control system and a control layer control system. The control layer mainly includes a fracturing truck control system and sand mixer truck control system. It mainly completes the control operation of each fracturing equipment; the management control system mainly includes the fracturing truck monitoring system, sand mixer truck monitoring system, fracturing construction data processing system and portable monitoring system, which mainly monitors the control layer equipment in real time and related data processing.

3.1 Management Control System

Each monitoring software system of the fracturing unit control system's management layer is developed and implemented in C # language on the PC and the palmtop computer on the vehicle instrument. It is the core work area of the fracturing unit control system. Each monitoring system is connected via Ethernet to achieve a large number of transmissions management layer connection. During the construction operation, each construction instruction is issued by the commander in the vehicle instrument through the data detection and analysis of each monitoring system, and combined with the on-site process requirements. The data comes from the server software of each control system in the OPC server.

Therefore, monitoring software of the management layer based on OPC technology can realize the monitoring and management of different control layer devices Regardless of the brand of controller in the control system of the control layer, it can read and write its required data through its corresponding server software to complete data analysis of relevant monitoring process. Among them, the portable monitoring system is installed in a handheld computer and is written in C # voice. This system mainly performs remote and portable operations on the fracturing vehicle, which can make the various data monitoring and functional operations of the fracturing truck away from the fracturing vehicle. The existence of control panels and vehicle instrument makes the operation of the fracturing unit construction site more flexible and convenient. The system can be directly connected to the switch of the vehicle instrument via Ethernet for networking, or it can be connected to a single fracturing truck switch separately for monitoring of a single fracturing truck. It can also complete the above two tasks through a wireless network mode.

3.2 Control layer control system

The main equipment in the control layer includes fracturing trucks and sand mixer trucks. The fracturing truck injects a high-pressure, large-displacement

fracturing fluid into the well, spreads the ground apart, and squeezes the proppant into the fracture. The controllable objects of the fracturing truck control system are mainly the engine and transmission case[3].

The function of the sand mixer truck is to mix sand according to a certain proportion and procedure, and supply the sand mixer fluid to the fracturing truck. At the fracturing construction site, the actual operation of the sand mixer truck is completed in the sand mixer truck operation room.

The main control equipment in the control system of each vehicle includes: PLC, switch, gateway, wireless transmitter, display screen. Each control device is connected to the switches of each system through Ethernet, and is equipped with a wireless transmitter. When the physical connection of the Ethernet is broken, the wireless network can be directly used for field network connection to complete the fracturing operation.

When the fracturing truck and sand mixer truck control system in the control layer adopts Ethernet connection, regardless of whether the same brand of PLC is used, the network structure can be used to build a network composition, which is compatible with fracturing equipment from different manufacturers. Therefore, the fracturing unit control system based on Ethernet and OPC technology can be more widely used in petroleum fracturing sites.

When the fracturing truck and sand mixer truck control system in the control layer adopts fieldbus connection, the network structure is divided into two cases:

First, the control layer devices are from the same manufacturer. When the same fieldbus is used, the control layer forms a fieldbus ring network and is connected to the OPC server after conversion, similar to the network structure; Second: Each device in the control layer is a control system of a different manufacturer. When using their own fieldbus (Control Net, Profibus DP, etc.), the same devices first form their own fieldbus network, or they can form their own fieldbus ring network, and then they are connected to the OPC server after conversion.

4 Fracturing unit control system implementation

In the control system of the fracturing unit control system based on OPC technology, each monitoring system of the management layer is a client in OPC. It is connected to the OPC server through Ethernet and reads the required data in the server software of the corresponding controller to complete the corresponding control. The key point of monitoring is to read and write the data in SIMATIC NET or NetLinx by the management control system. In C #, the main implementation of data interaction between client program and server is as follows:

```
OPCServer objServer; // Define OPC Server
OPCGroups objGroups; // Define group container
OPCGroup objGroup; // Define a group
OPCItems objItems; // items
try
{objServer.Connect ("OPC.SimaticNet", 10.9.31.100); // Establish a connection to the server}
catch (Exception ex)
{MessageBox.Show ("Error connecting to OPC Server:" + ex.Message.ToString ());
return;}
objGroups = objServer.OPCGroups; // connection group
objGroup = objGroups.Add ("s1"); // Add group
objGroup.UpdateRate = 200; // Define the data refresh frequency
objGroup.IsSubscribed = true; // Set the subscription status
objItems = objGroup.OPCItems; // Add item container
objItems.AddItem (item, index); // Add item
objGroup.DataChange + = new DIOPCGroupEvent_DataChangeEventHandler (objGroup_DataChange); // Subscribe to events
void objGroup_DataChange (int TransactionID, int NumItems, ref System.Array ClientHandles, ref System.Array ItemValues, ref System.Array Qualities, ref System.Array TimeStamps)
{// When the data changes, the number of items should be obtained through NumItems, and the value should be obtained through ItemValues.}
objItems.Item (1) .Write (value); // write itemvalue
```

In the above manner, the client can read and write related data in the OPC server through subscription. When SIMATIC NET and NetLinx are run in the OPC server, only the relevant data in different servers can be read in the client program using the above method.

5 Characteristics

The OPC-based fracturing unit control system can meet the increasing requirements of fracturing site data transmission, and also has the following characteristics:

(1)High compatibility: For the control layer control systems produced by different manufacturers, connect them to the management layer switch and through simple data setting, you can control the control layer devices of different manufacturers, eliminating the "Information Islands" problem in the fracturing unit control system.

(2)Multi-redundancy: Ring Ethernet can completely solve the problem of single-point disconnection in the network. At the same time, each control system has a wireless module, which can continue to maintain the normal construction of the site if the Ethernet network is down.

(3)Easily expandable: In the control system network structure diagram, a computer for monitoring and processing is added to the management layer, which can be achieved by simply connecting it to the vehicle instrument switch. If new fracturing equipment is to be expanded at the control level, simply connect its control system to a ring Ethernet.

6 Conclusion

At present, in the fracturing equipment produced by various fracturing equipment manufacturers, Rockwell controllers and Siemens controllers are the mainstream in the control layer. The fracturing unit control system based on the OPC technology introduced here has been successfully based on Siemens controllers and Rockwell controller-based fracturing equipment have been added to the network and have completed multiple operations at the fracturing construction site.

With the gradual improvement of the intelligence and integration of the construction site of the fracturing unit, the highly compatible, multi-redundant, and easily expandable fracturing unit control system is bound to be the development trend of fracturing equipment.

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