Digitalization of Electroplating Process based on XML Model

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Abstract: With the advent of the data era, the digitalization trend of electroplating production industry is irreversible. Aiming at the problem of insufficient digitization of electroplating production process, this paper comprehensively utilizes network technology, fieldbus technology, control technology and big data technology, and establishes an XML model. The parameters involved are digitized, the data model of the parameters involved in the electroplating production process is established, and the electroplating process is abstractly described, the data structure is simplified, and the digital operation process of the electroplating production process is realized. As a result, the electroplating production process in the electroplating industry has been digitalized, modularized, intelligent and automated.

1 INTRODUCTION

With the advent of the data era, all walks of life are in the digital transformation, the general trend of enterprise digitalization, production digitalization transformation is irreversible. The electroplating industry is also becoming more and more popular due to the application of digital automation, but the automation in the electroplating production process is mainly reflected in the automation of individual functions, and the process parameters involved in the process are still controlled by manual method, without real digitalization, resulting in the process data cannot be shared. Therefore, the electroplating production process is in urgent need of digitization.

This paper makes comprehensive use of network technology, fieldbus technology, control technology and big data technology, and establishes XML model to realize digitalization, modularization, intelligence and automation of electroplating production process in electroplating industry.

2 DIGITAL INFORMATION ARCHITECTURE OF ELECTROPLATING PRODUCTION PROCESS

In order to empower the electroplating production process with digitalization, all the values involved in the electroplating production process need to be digitized first, and then the data information is transmitted to the upper layer for use. The amount of data in electroplating production process is large and complicated, so it is necessary to allocate the data information reasonably. Based on the actual process of electroplating production process, the following digital information architecture of electroplating production process is designed.

In the digital information architecture of digital electroplating production process, we divide it into three layers: data acquisition layer, XML model layer, and application layer (as shown in Figure 1). The bottom layer is the data acquisition layer, which is used to collect all the parameters involved in the electroplating production and save it in the SQL database for the XML model layer to call. The second layer is the XML model layer, which transmits the data stored in the SQL database at the bottom layer to

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the upper layer application layer in the form of XML data, determines and maintains the mapping relationship according to the requirements, and exchanges data through the ADO interface for the parameters that require XML description. . The top layer is the application layer, which can directly display the data required by the user through the interface, and can also connect with the ERP system according to the requirements.

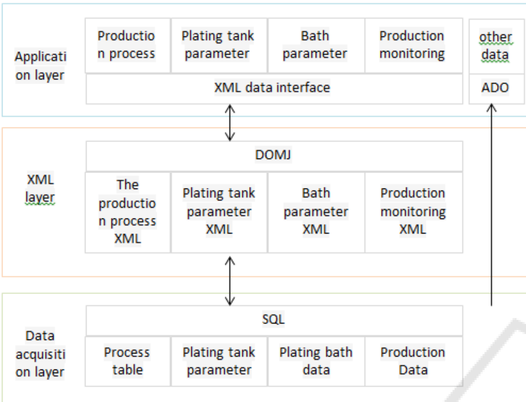

Figure 1: Digital electroplating production process information architecture.

3 DIGITIZATION OF ELECTROPLATING PROCESS PARAMETERS

According to the characteristics of electroplating production process, all parameters in electroplating production process are described in digital form. We abstracted the electroplating process. All complex process flows can be abstracted into three layers: process layer, process layer and parameter layer (as shown in Figure 2). The bottom layer is the process layer, and different processes can be developed according to the requirements of different plating parts. The middle layer is the process layer, and each process can be completed by multiple processes according to the process characteristics of different coatings, that is, this is a process chain list; The top layer is the process parameter layer, that is, all digital parameters in the process can be adjusted according to the actual situation, because each process maps different process parameters.

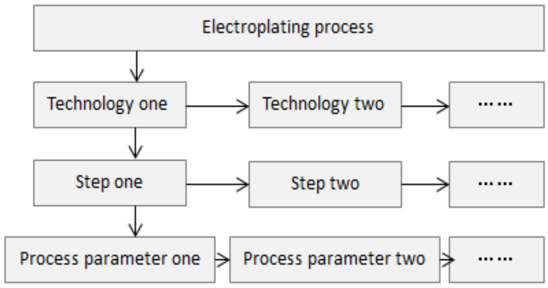

Figure 2: Schematic diagram of abstract structure of electroplating process.

4 XML MODEL LAYER FUNCTION CLASS MODELING

In order to improve the efficiency of electroplating production, the electroplating production process is abstracted, the repetitive operation is realized by applying XML code, and the predetermined production operation can be completed only by calling the specified method to establish XML model.

According to the schematic diagram of the abstract structure of the electroplating process in FIG. 2 , the parameters involved in the electroplating production process are described using an XML data model, and the electroplating process is described in detail using an XML document. In the XML root element tag <CarftInfo>, the tag <CarftID> is used to refer to the process number, the tag <Procedure> is used to describe the process content, the tag <StepID> in the tag <Procedure> is used to describe the process number, and its child elements refer to the process involved. parameters and values, and make corresponding adjustments to the data and structure in the program according to the properties and behavior of the object. In use, the XML data model needs to be parsed, but because the electroplating process changes less, we can use the tree-based JDOM for parsing, the output operation is more intuitive, and the XML document model can be better parsed, generated, Serialization and various operations.

UML diagram is a unified standard modeling language, which is used for visual modeling of software-intensive system. Its best application is engineering practice. Therefore, XML model is most suitable to display UML model diagram. In the XML model layer, the electroplating production process is abstracted, and according to the data characteristics involved in the electroplating production process, the electroplating process parameters, plating tank parameters, plating bath parameters and electroplating production process monitoring parameters are abstracted and stored in the XML data model, and then the UML function model diagram of XML layer function class is constructed. As shown in Figure 3, the XML_Base class has the ability to create XML, add node parameters, and query node parameters. In the figure, class XML_Craft refers to electroplating process parameter, XML_Trough parameter, XML_Bath parameter and XML_Monit parameter refer to electroplating production process monitoring parameter. All of these XML data classes are derived from the XML_Base class. The blocks and arrows in the diagram show the relationships and extensions in UML rules.

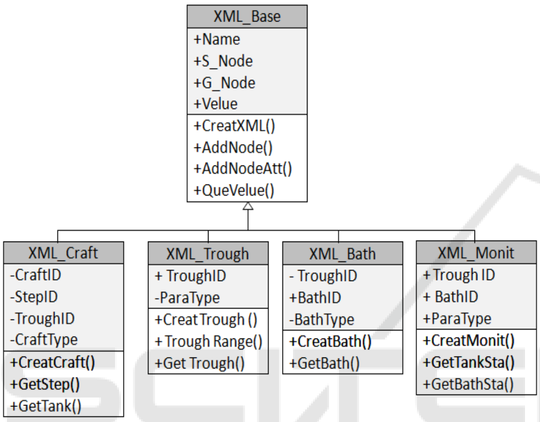

Figure 3: UML Diagram of XML layer functional class.

5 DATA COLLECTION OF ELECTROPLATING PRODUCTION PROCESS

The OPC server is used for data exchange, and the OPC server uses the Siemens CP5621 communication card, because CP5621 supports many types of fieldbus protocols, which can be used to collect various protocol data. It contains the corresponding communication program and data storage program, and provides standard OPC interface for communication. The schematic diagram of the hardware structure of the data acquisition layer is shown in Figure 4. According to the three types of objects of the OPC server, OPC is divided into three layers: OPC Server, OPC Grop and OPC Item: the top-level OPC Server has all the information of the server, and the OPC Grop group is set under it. Grop group provides a way for users to organize data, users can read and write it, and can also set the data update rate of the client, and when the data in the server buffer changes, OPC will send a notification to the user, and the user will be notified Then do the necessary processing without wasting a lot of time querying. There is also an OPC Item group under OPC Grop, which points to a register unit of the device. By defining data items, the special information of the device is hidden in the OPC specification to enhance the versatility of the OPC server. Since OPC Item does not define external interface, it is accessed through OPC group. OPC Item contains attributes such as value, quality, timestamp, etc. The data value is expressed in the form of VARIANT, which simply describes the data address. In order to greatly simplify the data structure and improve the transmission efficiency, the protocol specified by OPC is used for data interaction with the upper layer, so that switching between multiple protocols can be eliminated. And due to the large amount of data involved in the electroplating production process, the use of synchronous communication will cause delays, so asynchronous communication is selected to complete the data exchange.

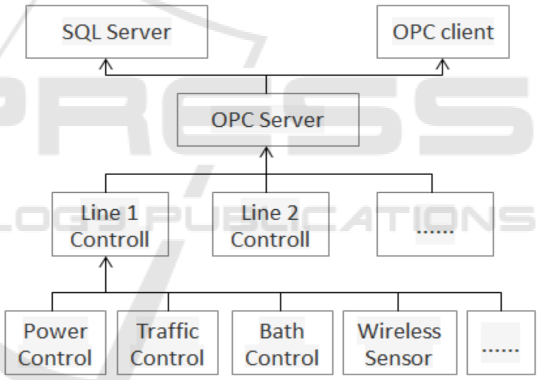

Figure 4: Schematic diagram of hardware structure of data acquisition layer.

5.1 Write Plating Process Parameters

How to write the electroplating process parameters into the electroplating production process is the key to realizing the digitization of the electroplating production process. Different process parameters need to be configured in the application layer according to different process conditions, such as production process control parameters and coating quality control parameters need to be configured separately. It also needs to go through various operation processes such as conversion, parsing, storage, and transmission, and finally complete the parameter writing.

After the process parameters are converted into an XML model according to the XML layer, they need to be parsed through the data layer, and then configured to the corresponding storage area in the relevant controller. Different electroplating processes correspond to independent OPC Group storage areas, and independent functional items in the storage area correspond to independent OPC Items. The FLAG bit indicates whether the storage area is occupied (FLAG=0, indicating that the electroplating process is terminated; FLAG=1, indicating that the electroplating process is in progress). The data item Item is an object defined on the OPC Server side, which usually points to a register unit of the device. The operation of the device register by the OPC user is completed through its data item Item, but cannot be directly operated on the OPC Item. All operations are Via the OPC Group object. When writing the electroplating process parameters, the XML model needs to be stored in the corresponding storage area, and then the value is passed to the corresponding data item. According to the writing procedure of the electroplating process parameters shown in Figure 5, firstly read the numerical value in the corresponding OPC Group to determine the position of the data area, then use the analytical function provided by the XML Craft class to read the XML file describing the electroplating process parameters, and finally set the numerical value Write the corresponding data storage area to realize the writing of the electroplating process parameters.

```
public bool DownCraft(XmlDoc pxd,string pID)
{//Read Free Data Area Code
int RID=GetFreeR(0);
bool BFlag=1;
int[] step=new int[50]
//Deposit plating process line
//Store PLC process line
int[] step_plc=new int[50]
XMLCraft p=new XMLCraft();
int IteCount=99;
object[] Val=new object[IteCount];
int StepCount=p.GetStep(pxd);
//Step number acquisition
step_plc=this.GetTANK(step_plc);
//Route writing
for(int i=0;i<50;i++){Val[i]=step_plc[i];}
//Parameter writing
for(i=0;i<StepCount;i++)
{string TankID;
TankID=p.TankID(pxd,i.ToString());
swich(TankID)
 {
//Parsing XML, writing process parameters
case"100":
Val[S0]=GetTime(p.AnaValue(pxd,i.ToString(),"Time"))
Val[S1]=ConTnt(p.AnaValue(pxd,i.ToString(),"Temp"))
Val[S2]=ConTnt(p.AnaValue(pxd,i.ToString(),"Cur"));
break;
case"101"
......
 }
}
//Parameter download
IntPtr Res_p=IntPtr.Zero
IntPtr Err_p=IntPtr.Zero
try{int[] err=null;
//Download process parameters to OPCGro according
 to data area
switch(RID){
    case 1:
//Data area 1 is free
    IOPCP_p.Write(ItemsCount,nItemProPal,val,out Err_
    err=new int[ItemsCount];
    Marshal.Copy(Err_p,err,o,ItemsCount);
  break;
  case 2:......
 }
}
if(Err_p!=IntPtr.Zero)//Error reporting
{BFlag=0;//Mark to zero
Marshal.Free(Err_p);//Release Resources
Err_p=IntPtr.Zero;
}
```

Figure 5: Writing Program of electroplating process parameters.

5.2 Upload Data of Electroplating Production Process

After the electroplating process parameters are written, they need to be uploaded to the server, and OPC is used as a data access tool to provide means to read and write specific data from the data source. An OPC server object OPCServer has an OPC group collection object OPCGroups as a sub-object. In this OPC group collection object, multiple OPC group objects OPC-Group can be added, and each OPC group object has an OPC item collection as a sub-object. Object OPCItems, multiple OPC item objects can be added to this OPC item collection object, and OPCItem is also used as an optional function.

First, the data is read by the upper-layer software OPC and then converted into XML data format to save, and then parsed by the application-layer software OPC as a numerical value, and the data is stored in a NoSQL database for preservation. When uploading real-time data in the electroplating production process, the item address under the corresponding OPC Group is the PLC address of the required data. The OPC specification specifies two communication modes: synchronous communication and asynchronous communication. Since the refresh frequency of real-time data is relatively fast, the synchronous reading method is adopted, and the function UploadXML(int[] val_p) is used to convert the array object into XML format. Return to complete the upload of electroplating production process data.

6 CONCLUSIONS

The digital transformation of the electroplating industry is irreversible in this era of big data, but the current digital automation of the electroplating industry is mainly reflected in the automation of individual functions. The data involved in the electroplating production process cannot be shared, and the control of process parameters is still manual. . In view of this situation, this paper comprehensively utilizes network technology, fieldbus technology, control technology and big data technology. According to the characteristics of electroplating process, the digital information architecture of electroplating production process is designed, the parameters involved in electroplating process are digitized, and the electroplating production process is established. The data model of the parameters involved in the process, and the electroplating process is abstractly described, the data structure is simplified, and the digital operation process of the electroplating production process is realized by using the XML model. As a result, the electroplating production process in the electroplating industry has been digitalized, modularized, intelligent and automated.

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