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Courseware Fabrication of Flue Gas Desulfurization of Limestone-gypsum for Multimedia Teaching

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Abstract

To improve teaching effects human computer interaction and animation are introduced to PowerPoint teaching platform based on conventional teaching methods. Flue gas desulfurization of limestone-gypsum of thermal power plant will be used to make teaching investigation as a sample in this paper since it is a mainstream technology in 300 MW coal-fired thermal power plants or more than the capacity. Authorware erects a bridge between PowerPoint and industrial technology to provide some demonstrations such as system recognition with equipments and its function, system operation with different substance flow and test questions with certain knowledge training. Utilizing Authorware tools a PowerPoint courseware embedded

by an executed file of macromedia Authorware 7.02 Runtime is formed, which has both numerous advantages of conventional courseware and substantial features of innovation. Under the aid of the courseware, not only lectures can expound those equipments and running working conditions of the desulfurization system clearly, but also learners can have a more profound understanding for mass transfer, heat transfer, momentum transfer and chemical reaction in an industrial process related to environmental protection of thermal power plant fleetly, which brings a fruit with a win-win both professor and students.

Keywords:Teaching Courseware, Authorware, PowerPoint, Flue Gas Desulfurization, Limestone-gypsum, Power production, Engineering Education

1. Introduction

Sulphur oxides is one of the main pollutants emitted by coal-fired thermal power plant, which accounts for a large proportion in atmospheric pollutants. Nitrogen oxide is another main pollutants discharged by coal-fired thermal power plant, its effects also should not be neglected. In order to solve the pollution problem of nitrogen oxide in power plant, a variety of control and emission reduction measures are applied [1-4]. However, key attention is sulfur oxides reduction for atmosphere in this paper. Currently, emission reduction approaches commonly used are wet flue gas desulfurization technology such as limestone-gypsum method, ammonia method, seawater method, semi-dry flue gas desulfurization technology such as spray-drying method, circulating fluidized bed and dry flue gas desulfurization technology such as electron beam, pipeline injection, and spraying calcium inside the furnace and tail humidifying activation and spray drying. In recent some references there are some reports on these abovementioned and relevant technologies like simultaneous capture of carbon dioxide and sulfur dioxide [5-6], like different absorbents [7-9] and like different reactors [10-11].

Facing complex and diverse flue gas desulfurization technology, a beginner wants to master them, who still need to spend a great deal of energy and time. However, for the instructor if they want to solve this problem of the beginner's time-consumption and energy-consumption, it is essential to improve and upgrade the courseware tool based on the traditional blackboard writing and basic teaching with a courseware of straightforward type. However, courseware investigation based on different software tools are limited to small scope in technologies[12-14] and in application fields[15-18].Due to its high desulfurization efficiency and a wide application range, the limestone-gypsum approach has become the mainstream technology of the flue gas desulfurization of 300MW coal-fired unit or of more than its capacity. If it can be used to be investigated as a teaching courseware demonstration sample of flue gas desulfurization technology, it will have a huge demonstration effect on other emission reduction technologies' teaching. In addition, Authorware as a conversant interactive software tool has played a role in a great deal of teaching software [19-21]. But there is a plenty of room to be excavated for more application areas. Thus, teaching courseware of the limestone gypsum flue gas desulfurization will be regarded as a research object to show vividly those contents of system equipment and mass flow process by the form of illustration by introducing the function of human-computer interaction and embedding executable file of Authorware in this paper. Finally, these effects will be reached, which is to strengthen teaching process flexibility of the instructor and to facilitate understanding of the desulfurization process of the learner synchronously.

2. Flue Gas Desulfurization Systems of Limestone-gypsum

2.1 Fundamental Principle of Technical Process

After the dust of raw flue gas is removed by dust catcher, raw flue gas will contact limestone slurry in absorbing tower and sulfur dioxide in the raw flue gas will be absorbed efficiently because of gas-liquid contact after they pass through gas-gas heat

exchanger or are cooled by spraying water. And then the clean flue gas after desulfurization will be discharged from a chimney or after they flow through reheating side of gas-gas heat exchanger. Simultaneously the slurry absorbed are used circularly. When the concentration of the gypsum in the slurry reaches a certain degree of saturation, it is discharged into the gypsum preparation system, where gypsum is prepared as by-products. The main reactions are written by formula (2-1), (2-2), (2-3) and (2-4):

$$SO_2 + H_2O = H_2SO_3 \quad (2\text{-}1)$$

$$H^+ + HSO_3^- = 2H^+ + SO_3^- \quad (2\text{-}2)$$

$$2HSO_3^- + O_2 = 2HSO_4^- = 2SO_4^{2-} + 2H^+ \quad (2\text{-}3)$$

$$Ca^{2+} + SO_4^{2-} + H_2O = CaSO_4 \bullet 2H_2O \quad (2\text{-}4)$$

2.2 Technological Processes and Systems

The wet limestone-gypsum flue gas desulfurization consists of three subsystems, which are flue gas treatment and sulfur dioxide absorption subsystem, gypsum dehydration subsystem and reaction agent preparation subsystem, respectively. Schematic diagram of the process flow chart is shown in Figure 1. The wet flue gas desulfurization system of limestone gypsum is composed of the following structures:

1. Limestone preparation system with a feed bin of limestone powder, a limestone mill and a measuring station.

2. Absorbing tower with a washing cycle, a demister and an oxidation procedure.

3. Flue gas reheat system with a rotary gas-gas heat exchanger and clean flue gas emissions system with a chimney.

4. Desulfurization fans.

5. Gypsum dewatering devices with a hydraulic cyclone separator and a vacuum filter belt machine.

6. Gypsum storage devices.

7. Wastewater treatment systems.

In above these systems and apparatuses, sulfur dioxide absorption of flue gas, gypsum generation and wastewater treatment will be completed when a power production is running normally.

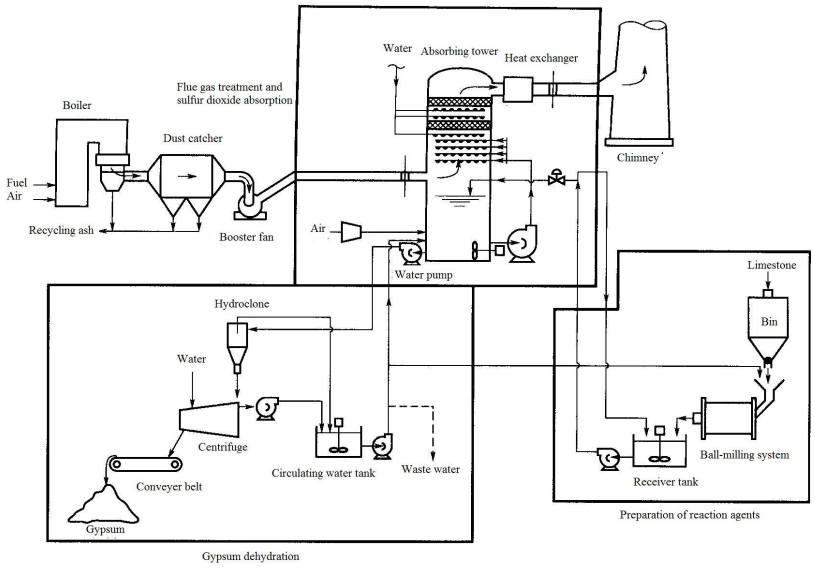

Fig. 1 Schematic diagram of flue gas desulfurization system of limestone-gypsum

3. Courseware Production

3.1 Multimedia Teaching Platform of PowerPoint

3.1.1 Courseware Frame of PowerPoint

According to the typical PowerPoint design project, set a home page and outline page. Necessary explanation such as a title of the paper, the authors will be given in home page. The frame structure of teaching contents will be elaborated in outline page. At the same time, set hyperlinks and buttons to enter the corresponding design page and make page conversion. Page specific styles are shown in Figure 2 and Figure 3.

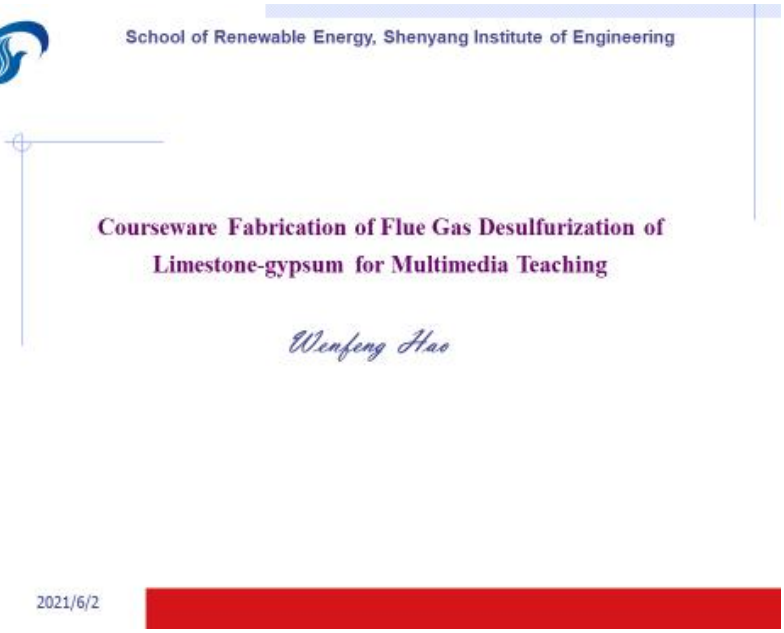

Fig. 2 Home page of PowerPoint

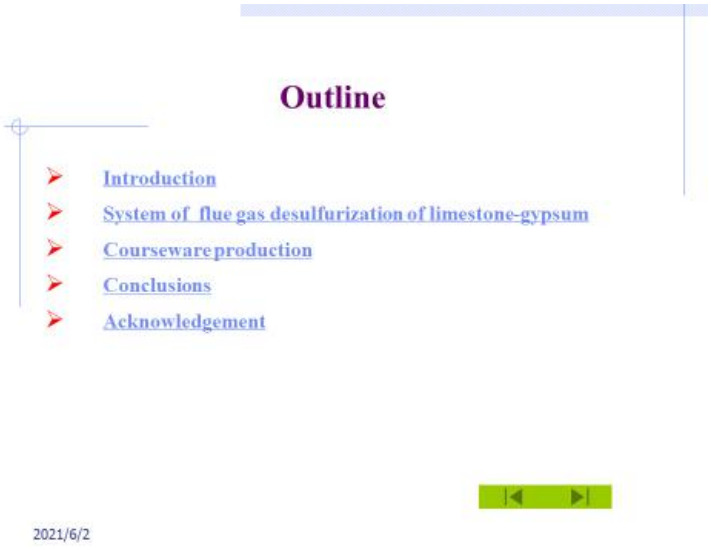

Fig. 3 Outline page of PowerPoint

3.1.2 Courseware Content

According to the outline order of this paper, the introduction, the limestone gypsum flue gas desulfurization system, the paper content production and conclusions are given. Further explanations of these parts are written as follows:

(1) Background, existing problems and solutions of the existing desulfurization technology are analyzed in the introduction part.

(2) Working principle and technological process of the limestone gypsum flue gas desulfurization system are illustrated.

(3) Form courseware teaching platform and use Authorware to produce an executable file of macromedia Authorware 7.02 Runtime including static equipment, dynamic running of working conditions and test questions in courseware production part. Afterwards, embed the executable file to PowerPoint and to do an essential demonstrations.

(4) Conclusions drawn and suggestions given will be given in conclusions part.

In view of the teaching contents, the production methods of teaching courseware have been widely used. However, teaching courseware with human computer interaction has few reports. In the result following sections will state a production of embedded software.

3.2 Production of Embedded Authorware Executable File

In order to make beginners of power engineering understand flue gas desulfurization process of thermal power plant in a relatively short period and expand the computer application software application in education and in teaching, modular design function of Authorware will be used to demonstrate clearly the process of the limestone gypsum flue gas desulfurization technology of thermal power plant and those related basic knowledge under the static and dynamic form. The design framework is shown in Figure 4, which consists of recognition system, the system run show and theory testing.

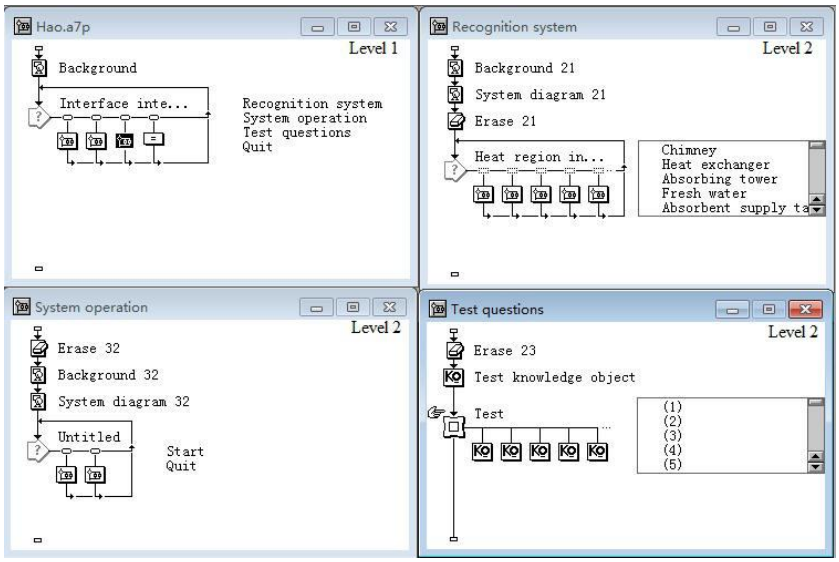

Figure 4 Schematic diagram of design framework

From Figure 4 we can understand that fundamental icons of Authorware such as display icon, interactive icon, frame icon, knowledge object icon and group icon, and the characteristics and integrated use of those icons can complete the framework design of the system.

3.2.1 Static demo

First of all, drag a display icon to design interface and adjust the attributes and specific functions, create and display an interface as shown in Figure 5. Then, using inserting object function of displaying icon of Authorware, the system diagram drawn by AutoCAD is imported into the design recognition system, as shown in Figure 6.

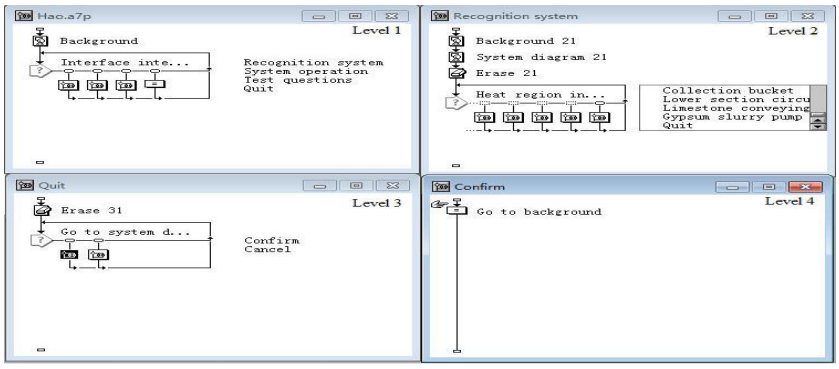

Figure 5 Initial interface design of the static demo

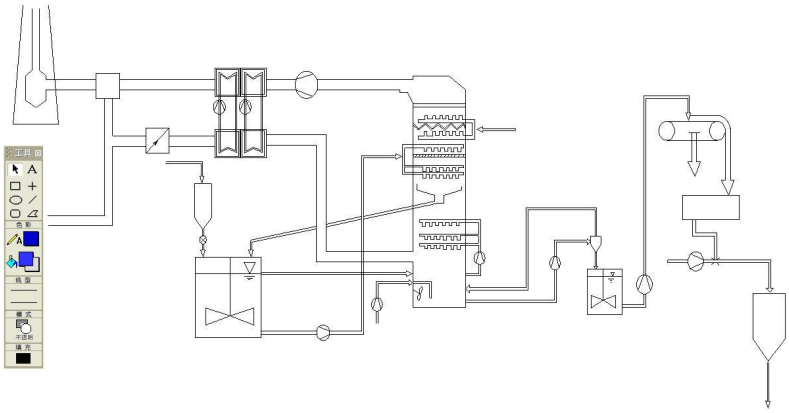

Figure 6 Import of system diagram

Second, make static cognition system. Analyze coal-fired power plant combustion system, limestone gypsum flue gas desulfurization, apparatus, process in this part and know the entire apparatus name and their respective roles then make "static cognition system". This part mainly use thermal interaction icon, drags a group icon and display icon into a flow line, the name, apparatus structure and function, and set a hot region. Regional scope is fixed on the device, and set a click. When click is implement instruction of the apparatus including structure and function will be shown. The lectures or software users can understand and learn the system by the static demonstration of the devices and apparatuses' functions. The design level of the recognition are shown in Figure 7-a. From the picture of Figure7-b, we can see that apparatuses and its functions can be stated distinctly. Not only it is easy to interpret apparatuses and theirs functions for the lecture of lessons, but also it is convenient to comprehend those equipment and theirs functions in the flue gas desulfurization process.

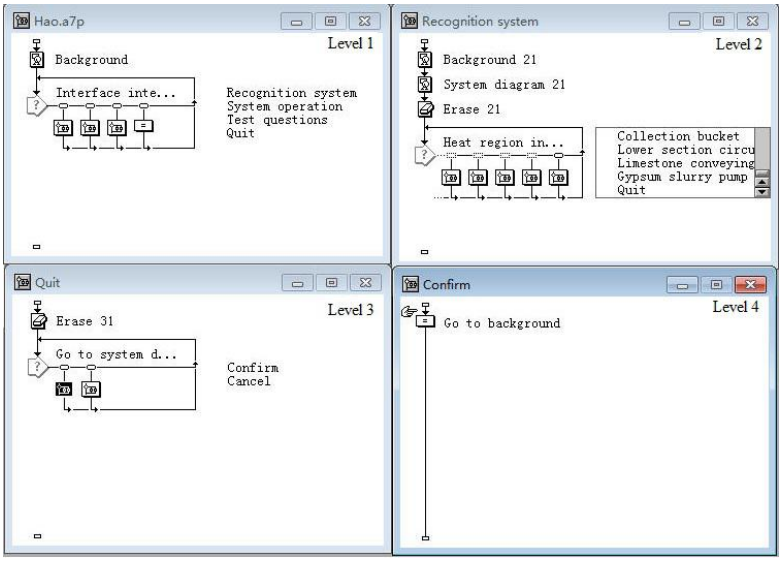

Figure 7-a Schematic diagram of "Cognition system" structure

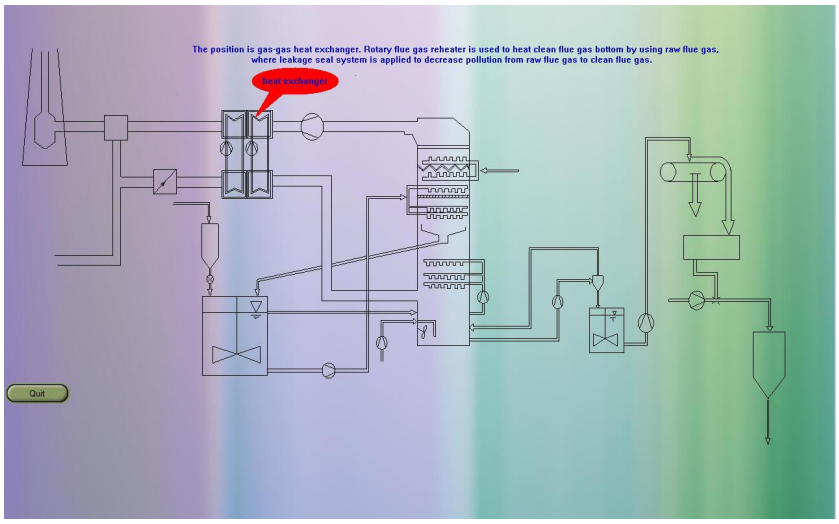

Figure 7-b Schematic diagram of static demonstration for the devices

Also button operation is applied into the design and operation of the system. Use a button to control the flow of the materials in different parts to facilitate the users of the software of the courseware of understanding, operation and intuitive understanding of the process. If you press the button of the operation, the flow of material such as flue gas current, calcium current, air current can be clearly shown according to the directions of flow. See dynamic demo subsection to understand these flow processes.

3.2.2 Dynamic Demo

Prior to schematic diagram generation for a limestone gypsum flue gas desulfurization, the combustion system of thermal power plants, combustion system, steam and water system and electrical system should be fully understood and master system in material, in energy conversion and in transfer process. Limestone gypsum flue gas desulfurization demonstration includes flue gas system, discharge system of ammonia, liquid ammonia evaporation supply and reaction system, the demonstration interface is shown in Figure 8.

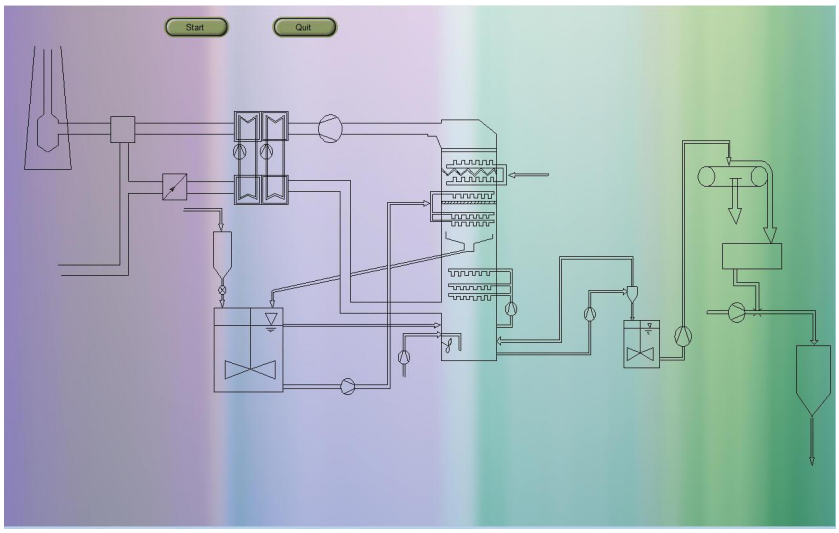

Fig.8 Operation interface of limestone gypsum flue gas desulfurization

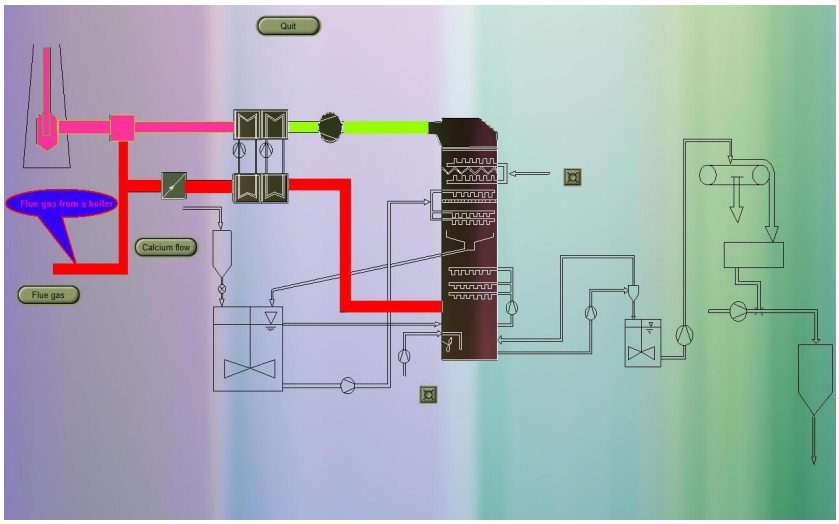

Fig. 9-a Flue gas flow chart

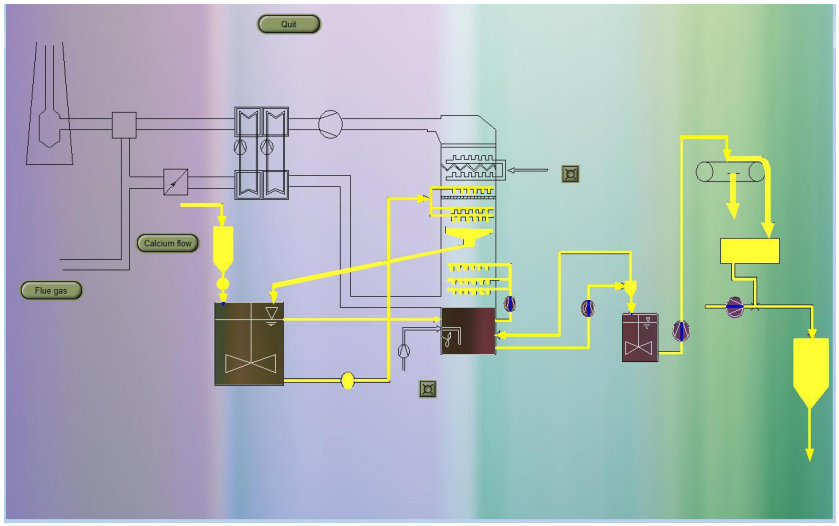

Fig. 9-b Calcium flow chart

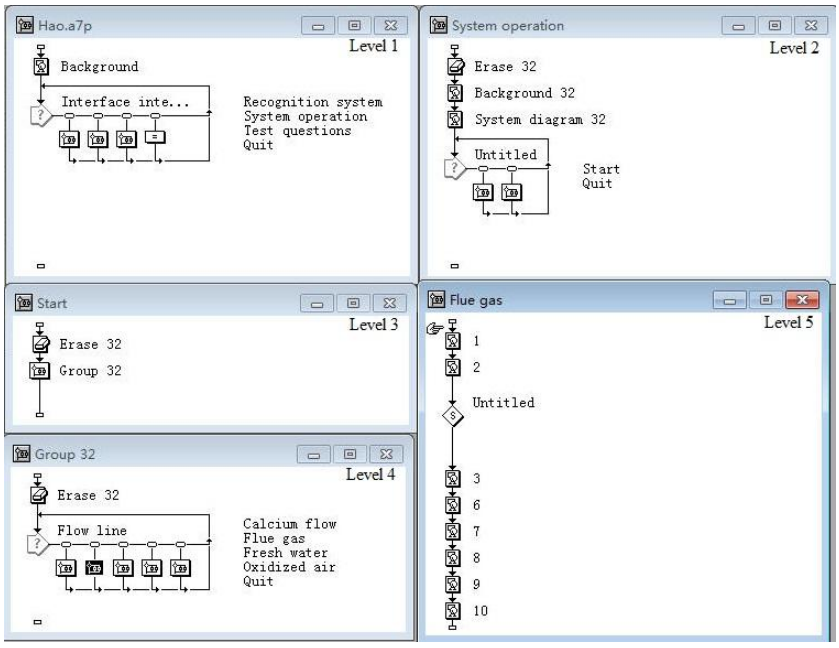

Fig. 10-a Production chart of flue gas flow

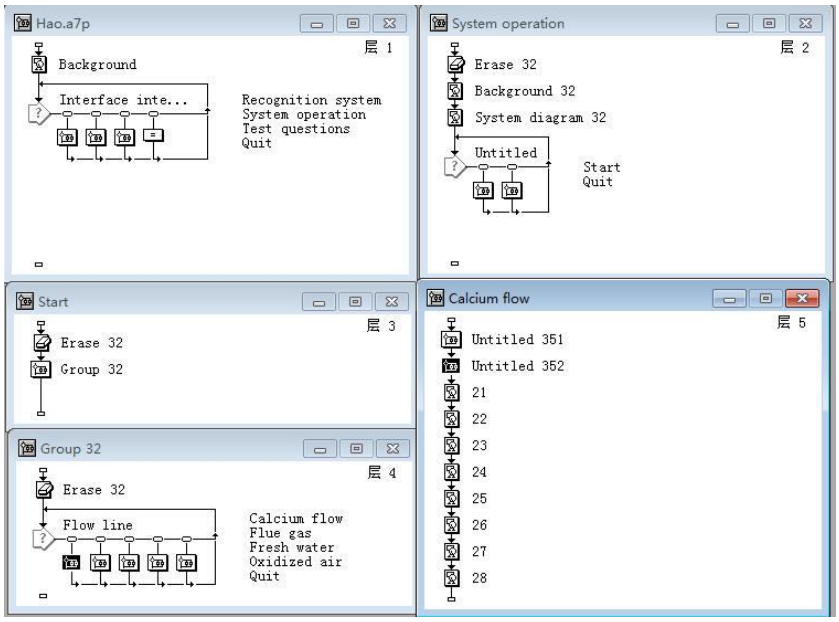

Fig. 10-b Production chart of calcium flow

For the production of dynamic demonstration of the running system, show of flue gas flow and calcium current as samples are used to reveal all kind of mass transfer processes in this paper. Coatings shown in Figure 9-a indicate a flow direction of the flue gas, whose run process can show process control of raw flue gas and clean flue gas in the system when a power plant runs under a normal state. Coatings shown in Figure 9-b reveal a trajectory of calcium current during the power plant runs. The process fabrication can be described as follows:

By using button interactive icon function button "start" and button "quit" are set up. Under the condition of the start button, using different levels of "group" icons the apparatuses and parts of different substances flow in terms of the order will be arranged in the upper and lower levels of the "group" icons, also special effects of the coating for each schematic diagram are set. After the program runs different substance will come out in an order with different special effects, and ultimately man feels that a substance is moving in apparatuses and pipelines. When button "quit" is pressed, when operation system will return to an initial interface as shown in Figure 4. The production process are shown in Figure 10-a and in Figure 10-b. The human-computer interaction is beneficial to understand and grasp mass transfer, heat transfer, momentum transfer and relevant rules to chemical reaction for the limestone

gypsum flue gas desulfurization processes whether those lectures or those learners.

3.2.3 Production of Test Questions

In order to increase to understand and grasp the application of limestone gypsum flue gas desulfurization in a coal-fire thermal power plant, functions of navigation and knowledge object are applied to make test questions. During the production of the test questions, a navigation icon and some knowledge object icons are firstly dragged into test questions framework. Then selection response including page size, background, types and number are done according to page hint. 30 singel-choices, production procedures and effects example are shown in Figure 11-a and Figure 11-b. From the study of the production process and the knowledge learn of flue gas desulfurization of thermal power plant, instructors can provide a platform for the consolidation of knowledge of flue gas desulfurization during teaching, while the software users will have a deep understanding of the software itself and the fundamental knowledge of the thermal power plant environmental protection.

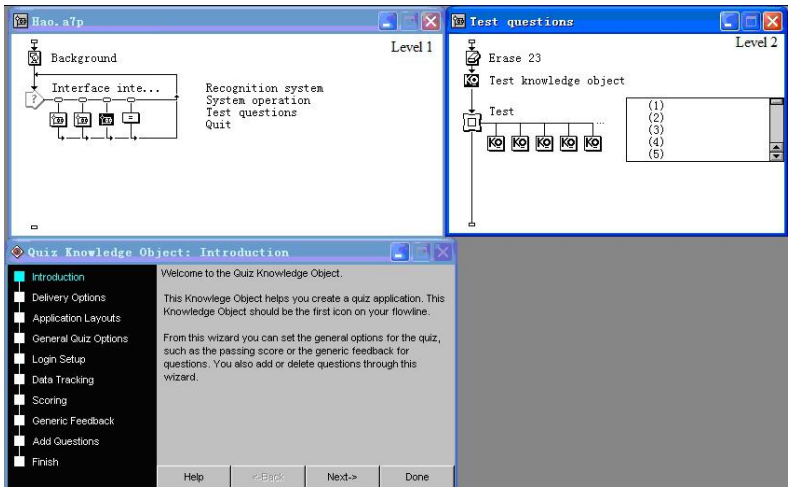

Figure 11-a Production process of test questions

Figure 11-b Run schematic diagram of test questions

3.2.4 Fabrication of an Executable File

Software with the static demonstration, the dynamic demonstration and the test question for flue gas desulfurization of limestone-gypsum is packed to become an executable file of macromedia Authorware 7.02 Runtime, which can be embedded to PowerPoint courseware in order to implement course teaching of human computer interaction by lectures. The executable file of macromedia Authorware 7.02 Runtime is embedded to PowerPoint teaching courseware of Desulfurization and Denitration Technology to Power Plant, which is employed in Live Telecast of Rain Classroom of xuetangx.com and which brings better teaching effect.

4. Conclusions

After teaching courseware aforementioned is completed an instructor it will be applied to lessons teaching. From courseware fabrication to normal teaching for the limestone-gypsum flue gas desulfurization process, following conclusions can be drawn.

1) Process flowchart and some fundamental knowledge of coal-fire thermal power plant can be demonstrated clearly under the static state and dynamic state by the modular design function of Authorware.

2) Test questions can provide a platform strengthening understanding and

prolongation of basic knowledge of the environmental protection whether for the knowledge transfer of lectures or for the knowledge absorption of learners.

3) PowerPoint teaching courseware with an executed file of Authorware has vivid characteristic compared to general courseware since human computer interaction and animation are introduced to courses teaching, which will have stronger representing ability and will gain better teaching effects than before.

4) Lectures will be easier to express the apparatuses and technical process and will be more convenient to teach mass transfer, heat transfer, momentum transfer and chemical reaction for all kinds of substances in the limestone gypsum flue gas desulfurization system.

5) Learners can not only have a more profound understanding of the materials, energy conversion and transfer processes of coal-fire thermal power plant, but also they can master the approaches of process modular design from their own continuous learning when they attend a lecture using this courseware and when the teaching mode is compared to conventional teaching.

6) Teaching practice shows that embedded multimedia courseware may achieve better effect whether instructor reveals software resources fully or learner grasps course knowledge rapidly when instructor teaches courseware fabrication or the executable file made is called as a plug-in.

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