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ABSTRACT
This paper aims at introducing how the author combines the Chlor-alkali & Polyvinyl Chloride Procedure and the chemical engineering unit operations, such as fluid flow and transportation, heat transmission, rectification, absorption and chemical reaction process in the teaching of Chemical Engineering Basic course. The combination makes the teaching become important, close to practice and easy to master. It obviously stimulates the students’ interest and achieves good teaching effects.

KEYWORDS: Teaching of Chemical Engineering Basic course, Chemical engineering unit operation and equipment, Chlor-alkali & Polyvinyl Chloride Procedure, Combination of theory and practice.

1. INTRODUCTION
Chemical Engineering Basic is an important engineering fundamental professional course, which is offered for undergraduates of chemistry and material chemistry majors (Wuhan University, 2009; Wang, 1992). It investigates chemical engineering theories and equipment of various chemical engineering unit operations involved in industrial processes, which presents the course’s application characteristic. So, it’s very important to select a typical chemical procedure and combine it with the study of unit operations such as fluid flow and transportation, heat transmission, rectification, absorption, chemical reaction process. Production of Chlor-alkali & Polyvinyl Chloride are traditional process (Zhang and Wei, 2013), and it includes many typical chemical engineering unit operations and equipment (showed in Figure 1) such as transportation of NaOH solution (corresponding to heat transmission), preparation of hydrochloric acid (corresponding to absorption), reformation of crude chloroethylene (corresponding to rectification), synthesis of HCl and polyvinyl chloride (corresponding to chemical reaction process) (Zhou and Ding, 2016). In the teaching of Chemical Engineering Basic course, the author combined the study of chemical engineering unit operations, related equipment and the Chlor-alkali & Polyvinyl Chloride Process, which made the learning process become well-documented and enlightening. It was interrelated and stated in second part of Exemplary Embodiments in detail.

Figure 1 Chlor-alkali & Polyvinyl Chloride Procedure schematic diagram

2. EXEMPLARY EMBODIMENTS

2.1 FLUID FLOW AND TRANSPORTATION
The purpose of flow and transportation is to transfer fluid with piping prepared with proper material to equipment at the demanded fluid-flow, and maybe transfer pump is required at the same time. After the study in the theory of knowledge, example of NaOH solution transportation in the Chlor-alkali & Polyvinyl Chloride Procedure was interrelated in this part. NaOH solution is corrosive with high temperature and pressure at the same time. Therefore, the transfer piping should be prepared with corrosion resistance material, such as 304 type stainless steel (Sui, 1995), and the pipe diameter could be calculated based on the demanded flux and velocity. Furthermore, a corrosion resistance transfer pump is required, for example, TL6-60 centrifugal pump with a design flow of 60m³/h and a lift of 60m. Its impeller and shell are prepared with 304 type stainless steel. 2G13 and 4F are used as material of axle and shaft seal respectively.

2.2 HEAT EXCHANGE
For chemical reaction or physical process, heat exchange between process fluid and heat carrier is normally required in order to get the demand temperature. In the teaching of heat exchange unit operation, the final purpose is to help students correctly select heat carrier and heat exchanger. Preparation of liquid chlorine in Chlor-alkali & Polyvinyl Chloride Procedure through compression and cooling operation can be cited as an example of heat exchange. After pre-cooling, drying, compressing, chlorine empties into the tube side of the first stage heat exchanger and is cooled by microthermal tail chlorine flowing in shell side. After that, it’s sequentially cooled by Freon with a temperature of -35°C in the second heat exchanger (evaporator). After the second time heat exchange, most of the chlorine turns into liquid state, and then liquid chlorine product and tail chlorine obtained after the separation. As for the Freon, it would vaporize and finally turn into vapour when indirectly contact and absorb heat from chlorine. Because the temperature of tail chlorine is lower than the initial temperature of chlorine, it can be used as coolant in the first stage heat exchanger.

2.3 ABSORPTION
Absorption is a kind of unit operation which is used for the separation of gas mixture with different solubility in a solvent, and it can also be used for the preparation of chemical product. In Chlor-alkali & Polyvinyl Chloride Procedure, hydrochloric acid is prepared through absorption of hydrogen chloride in water. Therefore, it’s cited as example of absorption, and some questions were put forward, such as: (1) how to turn hydrogen chloride into hydrochloric acid with the demanded concentration; (2) the selection of solvent; (3) optimization of operating temperature and pressure; (4) further treatment of offgas; (5) calculation of solvent dosage, number of transfer unit, height of transfer unit. The combination of theory with production procedure can make students better understand the importance and principle of absorption unit operation.

2.4 RECTIFICATION
Basing on the boiling point or volatility difference between different components, rectification unit operation is used to separate and cleanse of liquid mixture. It can not only be used for the purification of raw material solution, but also for the refinement of reaction product. The separation is carried out through the frequentative part vaporization of liquid mixture and part liquidation of gas mixture when they contacted on column plate or stuffing rectifying tower. The purification of chloroethylene was cited as an example of rectification. In Chlor-alkali & Polyvinyl Chloride Procedure, chloroethylene is the principal product of addition reaction between acetylene and hydrogen chloride, 1,2-dichloroethane is the by-product at the same time. Therefore, gas obtained from reactor contains chloroethylene, 1,2-dichloroethane and the residual acetylene, hydrogen chloroethylene with a mass ratio of 5~10%. To improve the purity of chloroethylene, a series of separation and refinement are demanded. As first, gas mixture is washed by KOH solution, and then it's imported into low boiling point rectifying column. In this rectifying tower, acetylene is distilled out from the top position, and then return to the chloroethylene synthetic reactor for its recycling.
reutilization. As for the mixture of chloroethylene and 1, 2 dichloroethylene, it's drained from the equipment bottom, and then imported into the second rectifying column. In high boiling point rectifying tower, 1,2 dichloroethanes drained from the bottom, and chloroethylene is distillated out from the top position with a purity of 99.99%.

2.5 CHEMICAL REACTOR
Chemical reactor is a kind of equipment to perform chemical reaction. When finishing the contents such as reactor types, calculation, and optimization, some typical relational procedure in Chlor-alkali & Polyvinyl Chloride Procedure were cited, such as the synthesis of hydrogen chloride and polyvinyl chloride. As for the preparation of hydrogen chloride with chlorine and hydrogen, it's a continuous gas-phase reaction with an reaction order of 2.0 (Zhang, 2014) and a heat release rate of 2522.85 kJ/mol. Based on the optimization of reactor and demand for heat exchange, a continuous tube reactor (graphite tube furnace) attaching with water jacket for cooling should be selected. For the suspension polymerization of vinyl chloride monomer in the presence of initiator, theoretically, a tube reactor should be chosen because the initiator reaction order is in the range of 0.5-1.0 (Shan, 2000). In actually, a batch stirring tank reactor is selected because it's very difficult to reach the ideal plug flow model in this high viscosity reaction system. At the same time, the strict control of reaction time is the key factor to insure a narrow molecular weight distribution of polyvinyl chloride.

3. CONCLUSIONS
Such examples are too much to cite. It's in favour of the combine of the oritical knowledge and production practice in the course education, and it urges the author constantly excavate the relation between Chemical Engineering Basic course and Chlor-alkali & Polyvinyl Chloride Procedure. It helps enrich the teaching contents, raise the teaching efficiency and promote the renovation of educational concepts. The teaching validity is obvious and well accepted by students.

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