

**DESIGN OF TRAINER UNIT MULTIPLE EVAPORATOR SYSTEM
MODEL FOR ELIMINATING OBSTACLES IN THE TEACHING
PROCESS OF REFRIGERATION SYSTEM CONCEPTUAL**

Syamsuri Hasan and Ricky Gunawan

Abstract: The goal of teaching process is to enable students in mastering the subject either in theory or in practice, where the latter is a conceptual application in real performance. The application process of the concept will need some aid of medium or educational equipment to perform the goal of a teaching process. This medium has a role in giving the information of teaching material from teachers or other sources which can encourage the students in fast comprehension. The goal of this research is to produce a cheap and representative aid / teaching medium. The aid / teaching medium will be a trainer unit multiple evaporator system model which contributes to the students in the teaching process of conceptual Refrigeration System.

The above research design is conducted by development research method approach. We hope this research method can reach the maximum research goal. The data needed will be obtained through literature study, documentation, observation, interview, questionnaire, and test. The field of science examining “Design/Developing of Aid and Teaching Medium. Aid and teaching medium is in relation with the teaching process of conceptual refrigeration system. The product is hopes to be able to reach the target of this research in the first year: Trainer unit multiple evaporator system models, and in the second year: module interactive, while in the third year: experiment and finishing touch result.

Based on the analyses and discussion, we found that: 1) Trainer unit multiple evaporator system model resulted from this research has fulfilled the terms of educational medium that is cheaper than the market sale. Further more, it is properly used for teaching visual aid and facilitates the conceptual comprehension. Thus, it can basically be applied to the real equipment, either as commercial refrigeration system or in industry. 2) Trainer unit multiple evaporator system model can overcome or eliminate any obstacles in the teaching process of refrigeration system, especially subjects in relation with multi evaporator and can give the basic competence.

Keywords: trainer unit, multiple evaporator system models, eliminating obstacles, teaching process of refrigeration system.

INTRODUCTION

The education based on competence demands sufficient educational facilities according to the material, so that the students can involve themselves in the activities. One of the facilities needed to self-study or in a small group is an aid/teaching medium which can be economically and relatively cheap according

to the Indonesian economic condition at present. The teaching medium as an aid equipment in the field of refrigeration engineering skill and air conditioning are quite expensive that it is hard enough to afford it with the restricted educational fund. One of the college courses which has not been supported with educational/teaching medium is Advanced Refrigeration System – now Multiple refrigeration and Cryogenic.

The implementation of competence based curriculum demands teaching system focused on students that is the students have to be active to reach the competence degree according to the teaching material (active student method). The implementation can flow smoothly and perfectly when there are medium and infrastructure for the implementation of the teaching process. The medium needed in the teaching process is an aid/educational or teaching medium and we also need the same medium to support the teaching process of refrigeration system.

Considering how small the fund is, it is very hard to obtain an aid/teaching medium which has a representative and sophisticated quality according to recent technological development. The same obstacle can be found in the college course being developed at Kelompok Bidang Keahlian Pendidikan Teknik Pendingin concerning the problem of refrigeration and air conditioning. So far the subject Advanced Refrigeration System or Multiple refrigeration and Cryogenic are performed conceptually (based on theory) and orally, because it has not yet been supported by teaching aid for application (practice). One of the main materials in the subject is: Multiple Evaporator and Compressor System. The fact in the daily life there has been such a lot of invention in refrigeration and air conditioning equipments in relation with this main material. The influence of conceptual verbal teaching system has caused the students lack of knowledge about the engineering equipment they are studying. Students as teacher candidates have not obtained a strong foundation to apply their engineering knowledge in the relevant job field (in school or in industry). Surely they will encounter difficulties in keeping up with the development and rapid technological progress, especially in relation with electronic and computer. There is some information from the students who have involved themselves in industrial practice and alumni who

have got jobs, that in the job field there have been so many equipments or refrigeration and air conditioning machines which use multiple evaporator and multiple compressor systems. They hope that providing the aid/ teaching medium in this subject will supply the students with a better comprehension about the material and also to avoid confusion when they find the equipment in the job field.

A. Design of Trainer Unit Multiple Evaporator System Model as a Teaching Medium

1. The significance of Teaching/Learning Medium

Teaching medium consists of all sorts of teaching components available around the student's environment which can stimulate learning (Gagne, 1970 copied by Ishak Abdulhak, 2003). Medium or teaching aid is a fundamental necessity and has a supplementary character in reaching the goal of teaching process successfully. According to Sudjana and Rivai, there are two prominent aspects in the teaching methodology: teaching method and teaching / learning medium as an aid device. Further, Ishak Abdulhak said that the teaching medium may include human, material, equipment or activities used for distributing messages which can stimulate mind, feeling, attention and motivation of the students, so that they get in themselves a learning stimulant. Teaching/learning process in arousing the students' motivation will need an aid device which can concentrate mind, feeling, attention, and motivation of the students in understanding the concept they are studying (Ibrahim and Syaodih, 2003, pg.112). Obviously the teaching medium is needed in any teaching or teaching/learning process.

The use of teaching/learning medium will need to consider the cheap price, efficiency and affordability of the educational institute without rejecting the possibility in using modern medium according to technological demand. So, educational medium as an aid device must be able to be reached by educational institute with a cheap price and efficiency. According to Nurdin, & Co (1982), the requirements of educational medium are:

- a) Rational, according to ratio and thinkable by the inventor.

- b) Scientific, according to the scientific development.
- c) Economical, according to the affordable fund.
- d) Practical, can be used in the practical situation in school and simple in characteristic.
- e) Functional, useful in the teaching and can be used by teachers and students.

According to Sudjana and Rivai, 2001, the advantages of teaching/learning medium are: a) the teaching will be more interesting and so that the motivation will grow, b) the teaching/learning material will be clearer in meaning, easy to understand, and easy to reach its goal, c) giving variation to the teaching method, and d) the students will do more learning activities. The advantage of teaching/learning medium in the teaching/learning process is the ability to make a more conducive atmosphere and enhance activities. One important factor is that the teaching/learning medium can heighten the students' learning process in the teaching/learning, so that finally it can heighten the achievement result of learning (Sudjana and Rivai, 2001, pg.2). The existence of teaching/learning medium is to support the teaching/ learning process, so that the students can understand the teaching material and finally can reach a satisfied result.

2. Design of Trainer Unit Multiple Evaporator System Model as an Educational/ Teaching Medium in the Advanced Refrigeration System

The effective and efficient teaching is done for example by applying creative teaching from Muhamad Muhtar (<http://www.pikiranrakyat.com/cetak/2005/1105/29/1106.htm>). One means of creative teaching is by making a teaching/learning medium which can motivate the students in the teaching process. It is better if the learning medium is made by teachers so as to suit the requirement, and it can be made in a simple form.

The teaching/learning medium is divided in two categories: two dimensions and three dimension. The three dimension model consists of: solid model, cut-away model, and diorama model. Trainer unit as a teaching/learning medium constitutes a combination between working model and mock-up model. Based on the definition given by Sudjana and Rivai (2001), working model is an imitation of an object which exposes the outer side of the original object, and it

has some parts of the real object. As for the mock-up model, it is a simplified structure of the main part of a more complicated process or system. The real structure of the main parts is modified so that the main aspects of a process can be easily understood by the students. Here below is a list of instructional medium group according to Anderson (1976), copied by Ikhsan (<http://teknologi-pendidikan.wordpress.com/2006/03/21>)

Table 1 List of Teaching Medium Group

| MEDIUM GROUP | INSTRUCTIONAL MEDIUM |
|-------------------------------|---|
| 1. Audio | <ul style="list-style-type: none"> • audio tape (roll or cassette) • audio plate • radio (broadcast recording) |
| 2. Print | <ul style="list-style-type: none"> • programmed text book • manual book • task book |
| 3. Audio-Print | <ul style="list-style-type: none"> • exercise book (with cassette) • picture/poster (with audio) |
| 4. Static Visual Project | <ul style="list-style-type: none"> • slide • serial film (contains verbal message) |
| 5. Slide Project with Audio | <ul style="list-style-type: none"> • slide with sound • serial film with sound |
| 6. Movement Visual | <ul style="list-style-type: none"> • dumb film with caption |
| 7. Movement Visual with Audio | <ul style="list-style-type: none"> • sound film • video/vcd /dvd |
| 8. Object | <ul style="list-style-type: none"> • real object • mock-up model |
| 9. Computer | <ul style="list-style-type: none"> • computer based medium; CAI (Computer Assisted Instructional) & CMI (Computer Managed Instructional) |

Trainer Unit is a set of teaching/learning medium in the laboratory, in the form of original object which has been arranged in such a way according to the requirements of the above working model and mock-up model. Trainer Unit is made to assist the students' learning in applying the knowledge/concept they have got toward real objects. This equipment can be used to reach basic competence, because it can be used for practice in understanding the job as in industry. Usually the trainer unit is equipped with module as a directory in the learning process. The

involvement of teacher/trainer in the learning process with this equipment and module can be minimized in such a way as a facilitator.

Some steps in designing or developing trainer unit model multiple evaporator system:

- a) studying the concept of refrigeration system with multiple evaporator material
- b) counting the factors based on the above concept
- c) fixing the use of material and equipment needed according to the result of counting
- d) preparing the trainer unit table according to the obtained measure requirement
- e) arranging trainer unit model multiple evaporator system to make the teaching/learning aid/medium

B. The effectiveness of the Trainer Unit Multiple Evaporator System Model in the teaching process

1. The conceptual teaching of Refrigeration System

Refrigeration System is a process to maintain the room temperature or substance/object so as to stay lower than the surrounding temperature. This process will occur when there is equipment/machine which can be used for this purpose (Sarao, AS. and Gaabi, PS., 2001). As an equipment to maintain temperature to stay lower than the surrounding air, refrigeration system is widely used in social life, either for preserving (food) or for producing goods in the industry. Refrigeration equipment/machine consists of four main components: evaporator, compressor, condenser, and refrigerant control equipment (resistant device for refrigerant expansion). Besides, there is an additional device for maintaining the work of the machine according to the desired temperature, e.g. thermostat, compressor control equipment, etc.

The subject of Advanced Refrigeration System (Multiple refrigeration and Cryogenic) only gives one side of cognitive ability/competence, but doesn't give the applicative activity. The teaching process only has a verbal characteristic. It means that the students only listen and understand what is given by the teacher at the moment they meet. As for the task given, it is in the written form either in the form of calculation or analysis. There aren't yet any tasks to refer to the skill,

attitude, and appreciation of the students in the job field to reach competence. The engineering task/practice constitutes the real job and it can be useful in the future. The realization of this task all at once is to train the students in achieving the minimum competence which is relevant with the real job in the job field (education and industry).

2. Teaching with Trainer Unit Multiple Evaporator System model in the Refrigeration System

In the teaching process of the subject Advanced Refrigeration System (Multiple refrigeration and Cryogenic), the students will be given the opportunity to apply the lecture material/concept at the trainer unit. The trainer unit as a result of this research can be relied in minimizing miss-technology and obstacles in the subject of Advanced Refrigeration System (Multiple refrigeration and Cryogenic) which they are learning and make them easy to understand the material. That is why the students are expected not to find any difficulties during the implementation of field job practice or in industrial practice and also after they got jobs.

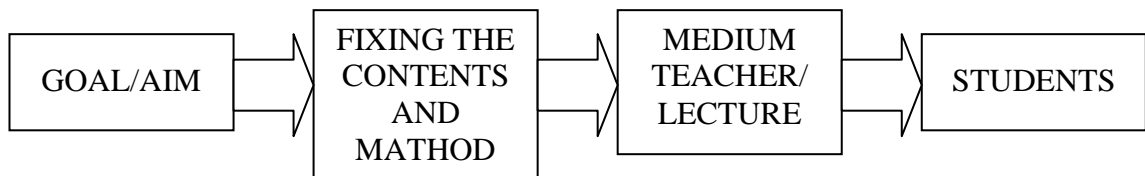
According to Ikhsan (2006), Edgar Dale clearly gave a stress about the significance of medium in education through pyramid/cone graphic as follows:



Picture 1 Pyramid/Cone Graphic of Stages in Educational Medium

According to Edgar Dale's pyramid, it can be seen that the students learn conceptually (theoretically) and they just listen, have a low grade of comprehension: about 20%. If the students in the active learning do the job themselves either by simulation or by the real object, so they can get about 90% of the information. Later on they can learn through simulation with multimedia interactive module and after they understand well, they can continue to learn by using Trainer Unit Multiple Evaporator System Model. It is hoped that the students can get as much information as they can from their study result and meet the criteria of Edgar Dale (90%).

According to Sudjana and Rivai (2003), that is if the students have possessed high discipline in learning, sufficient learning experience, and mature way of thinking, so the interaction of learning/teaching can be performed directly among the students with the teaching/learning medium having been prepared by the medium experts or by the teachers. Later on, the medium which is directly used by the students is called medium teachers/lecturers.



Picture 2 Context of Fixed Educational Medium

The students can perform directly the learning activity by using the information about the goal, fixing of the contents and method, and the usable medium. Students having high discipline, learning experience and way of thinking can interact directly with the trainer unit multiple Evaporator system model in the learning process of refrigeration system.

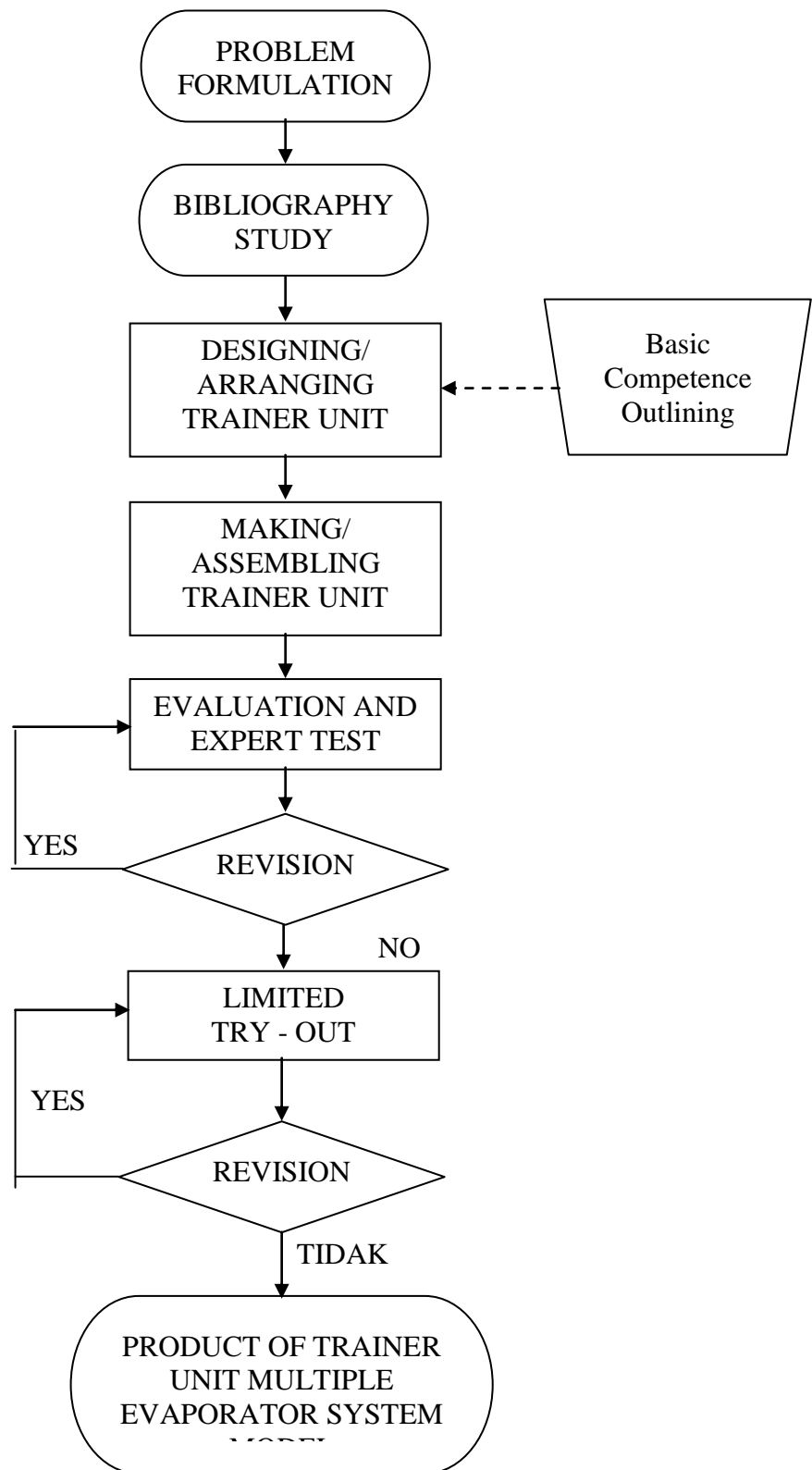
C. Relevant Research

The result of the research which has been done by Syamsuri Hasan and Ricky Gunawan in February 2006, is as follows: 1) The application of refrigeration concept in the assembling of the trainer unit in the subject of Refrigeration System can be done by the students significantly according to the

material concerning refrigeration which has already been informed. 2) A medium or a teaching aid equipment has been produced, which can be used in the teaching process. The medium, which is in the form of trainer unit has been assembled by the students, and it can readily be used for medium or teaching aid equipment in the learning/teaching activity process, especially in the department of Refrigeration and Air Conditioning Engineering Specialist.

The goal of the research is a standard to direct the researcher in searching data so as not diverge from the stated problem. So the goal is to produce teaching medium/aid equipment which is relatively cheap and representative. The teaching medium/aid equipment is in the form of trainer unit multiple evaporator system models, which can be a contribution to the students in the teaching process of Refrigeration System conceptual. The success of this research can give a contribution in solving the educational problem, especially in relation with the teaching process of refrigeration system, so that the relevant competence can be obtained with the field job in refrigeration and air conditioning technology.

The design of the above research has been done with the development research method approach. We hope with this research method, the maximum research goal will be reached. The Department of Science with a study of “Design/Development of Aid Equipment and Teaching Medium”. This aid equipment and teaching medium are in relation with the teaching process of conceptual refrigeration system. The target and expected result from this research are the first year that is in the form of trainer unit multiple evaporator system models. The research has been done along one year, located in Bandung. All the data for this research have been obtained according to documentary study, literature study, observation, interviews, and tests (written tests and skill).



Picture 3 the Diagram of Research Activities Stage I

THE RESULT OF DATA ANALYSIS

The data collection of lectures/education-training about multiple refrigeration evaporator model machine which is studied in the SMK and Polytechnic Department of Refrigeration and Air Conditioning Engineering, is a part of the subject Maintaining and Repairing Refrigeration System, while in Polytechnic it is included in the subject Refrigerasi Terapan (Refrigeration System Group). The result of outlining basic competence which must be reached in the SMK department of Refrigeration and Air Conditioning Engineering, is maintaining and repairing multi system of refrigeration, cascade, and ultra cold, while the sub competence are : a) Tracing and fixing the disruption of the system and multi level component, cascade, and ultra cold. b) Repairing/replacing the damaged component in the system and multi level component, cascade, and ultra cold. c) Re-assembling the system and multi level component, cascade, and industrial ultra cold (Sumber Kurikulum SMK Teknik Pendingin dan Tata Udara, 2004).

While from the curriculum of Polytechnic – TEDC Bandung, we have obtained some information about competence: a) Assembling/testing refrigeration system from domestic, commercial and industry. b) Maintaining and repairing domestic and commercial refrigeration unit: cold storage, walk-in cooler, walk-in freezer, ice cube maker, reach-in cabinet, dispensing freezer, water/bottle cooler, cold drink vending machine. While the standard of Industri Teknik dan Logam (2001) has stated some requirements for competence: a) Maintaining and repairing multi stage cascade refrigeration system and/or ultra cold refrigeration system for industry. b) Handling the examination/adjustment/maintenance/precaution of the refrigeration system used in industry – multi stage, cascade, and/or ultra cold. c) Handling obstacles/troubles in the refrigeration system used in industry – multi stage, cascade, and/or ultra cold. d) Repairing/replacing wrong components. and e) Repeating the service to the refrigeration system used in industry – multi stage, cascade, and/or ultra cold.

The result of the research product is in the form of one trainer unit multiple evaporator system models. There are two evaporators used in this trainer

unit refrigeration system which are located in a refrigeration cabin. Each evaporator has 5°C temperature for the upper side cabin, and 5°C for the lower side. Refrigeration system consists of main components: two evaporators, compressor, condenser, and expansion valve. The test result is quite satisfying; despite of some points which need re-arrangement to meet the required arrangement, especially in relation with temperature. After being re-arranged, the desired temperature can be reached. The trainer unit multiple evaporator system model as the result of this research is relatively cheaper than those sold in the market or industrial product.

Based on the conclusion as an adjustment result by educational medium expert, this medium in general is suitable to be used as a visual display in teaching, either to explain concepts or as conceptual application in relation with the refrigeration lecture material. This visual display can also be used for classical teaching or small group teaching (5-6 per group). However, there are still some technical problems which need completion, especially in giving the name table for each component. And in relation with this equipment procedure, it is also provided with handout and job sheet.

Limited temporary test of the aid device/educational medium Trainer Unit Multiple Evaporator System models with the students as subjects who have taken the lecture Multiple Refrigeration and Cryogenic. The data obtained is as follows:

a. Observation result

The students can do the temperature measuring of the evaporator I with the same scale for each, despite the difference from what is desired. The measuring result shows 7.5°C, while it must be 5°C. So, the equipment needs control resetting. The same with the measuring result of the evaporator II, the difference is quite significant: the scale shows -12°C while it must be -5°C. About the temperature, it is suitable with what is desired: between 30°C and 32°C. The pressure can be read from the measuring device which shows suction 13.25psi (0.93 kg/cm²) and discharge pressure 132.6psi (9.3 kg/cm²). Their result of observation towards sight glass is that the refrigerant is in liquid condition after it is cooled in the condenser. The result of the observation towards the electric

system: electric cable series, current control and electric power, and compressor control device – all are in good condition and function as usual. They also did leakage test of the refrigeration machine system, and it appears that there is no leakage of refrigerant. But they didn't make the refrigeration machine system vacuum from refrigerant or filled it with refrigerant, because both of them have been done by the students and technician during the finishing of the trainer unit multiple evaporator system models.

Based on the above analysis, the students have been able to do the temperature measuring to the evaporator I (cabin I) and evaporator II (cabin II), pressure measuring of the suction and discharge, observation on the changing of phases through sigh glass, and testing the leakage of refrigerant. So, it means that the trainer unit multiple evaporator system models have been able to function well, despites the need to re-adjust the temperature control device.

b. The result of questionnaire

The positive opinion of the students about trainer unit multiple evaporator system models were revealed through questionnaire. This educational medium has been given them a better comprehension about the concept/theory, especially in relation with multiple evaporator material. They can understand the principle of the real operation of the multiple refrigeration system with two evaporators, two expansion valves, and one compressor, understand in detail about the components of multiple refrigeration system, able to watch and to analyses directly the multiple refrigeration system (evaporator) which concept has been given in class, can be a foundation to apply at the real installation. So, with the existence of the trainer unit, they can understand the refrigeration system concept more easily, especially the refrigeration with multiple evaporator. So, it means that this trainer unit can overcome or eliminate the troubles in the conceptual teaching process of refrigeration system.

DISCUSSION

The basic competence which is taught in SMK Department of Refrigeration and Air Conditioning Engineering is maintaining and repairing the

multiple refrigeration system, cascade, and ultra cold. Polytechnic Study Program of Refrigeration and Air Conditioning – Polytechnic TEDC Bandung has given some statements about competence : maintenance and reparation of commercial refrigeration unit : cold storage, walk-in cooler, walk-in freezer, ice cube maker, reach-in cabinet, dispensing freezer, water/bottle cooler, cold drink vending machine. While one point of the competence standard of Industri Teknik dan Logam (2001) is maintaining and repairing multi stage-cascade refrigeration system and/or ultra cold refrigeration system for industry. Based on the above basic competence, it means that we need to plant both concept and practice to the students who take the department of Refrigeration and Air Conditioning Engineering, concerning the material of multiple refrigeration and evaporator multiple system or multi stage for commercial and industry. One of the efforts to give basic competence is by giving stimulation through educational medium, especially trainer unit multiple evaporator system models. This trainer unit can function as visual display and also as practical device for practical necessities, for instance measuring temperature, pressure, ampere, and also for trouble-shooting.

Teaching medium is needed in every teaching process or learning/teaching process and it may include all kinds of things: human, material, equipment or activities used to convey messages which can stimulate mind, feeling, attention and motivation of the students so that the meaning is clearer, easy to understand, able to reach the goal, able to enhance learning in themselves, enhance learning activities, and able to heighten the result of learning. The use of teaching/learning medium needs to consider some factors: rational, scientific, economical (relatively cheap price), efficient, practical, functional, and affordable by educational institute.

The research product is one trainer unit multiple evaporator system model. There are two evaporators used in the trainer unit refrigeration system and they are located in the refrigeration cabin. Each evaporator has 5°C temperature for the upper cabin and 5°C for the lower cabin. The Refrigeration system consists of main components: two evaporators, compressor, condenser, and expansion valve. This trainer unit multiple evaporator system model as a product of the research is

relatively cheaper than the market and industry price. The educational medium specialists confirm that this medium is usable as a visual display in teaching, either for explaining concepts or conceptual application in relation with the refrigeration lecture material. This visual display can also be used for classical teaching or small group teaching (5-6 per group).

Trainer unit multiple evaporator system has been able to help the students to measure temperature in evaporator I (cabin I) and evaporator II (cabin II), measuring suction and discharge pressure, observing the phase changes through sight glass, and testing refrigerant leakage. So, it means that the trainer unit multiple evaporator system model has been able to function well, despite of the need to re-adjust to the temperature control device. The above students' opinion about trainer unit multiple evaporator system model is positive, because with the existence of this educational medium they can understand more about concepts/theories, especially in relation with the multiple evaporator material. Further more the students can understand about the real job principle of multiple refrigeration system with two evaporators, two expansion valves and one compressor, and understand in detail about multiple refrigeration components, able to observe and analyses directly the multiple refrigeration (evaporator) system which concepts have been given in class, able to be made as a foundation to apply to the real installation. So, with the existence of the trainer unit they understand more easily about the concepts of refrigeration system, especially refrigeration with multiple evaporators. It means that this trainer unit can overcome or eliminate the obstacles/troubles in the conceptual teaching process of refrigeration system.

CONCLUSION RESULT

Based on the discussion of the research result, there are some significant points which can be a conclusion of this research:

- 1) Trainer unit multiple evaporator system model which has been produced through this research has fulfilled the requirement of the educational medium, especially from the cost point, it is relatively cheaper than which are sold in

the market, usable as a visual display in teaching, facilitates the conceptual comprehension of the previous material, and able to be a foundation for the application to the real equipment in the job field, either as a commercial refrigeration or in industry.

- 2) Trainer unit multiple evaporator system models can overcome or eliminate obstacles/troubles in the teaching process of refrigeration system, especially in relation with multiple evaporators and it can also give the basic competence.
- 3) Trainer unit multiple evaporator system models are supported by the name labels of components so as to make the students easier to remember and comprehend. The operation is provided with handout and job sheet.

SUGGESTION

After studying and understanding this research result, there are some points which need to be considered as an input for the researchers themselves or for the teachers:

- 1) Trainer unit multiple evaporator system model can function as self-teaching for the students if the handout and job sheet are replaced by interactive modulo, so that the benefit of this equipment will be greater. We hope that the interactive module can be made in the coming research that is in the second year according to the research plan.
- 2) It is best to make the trainer unit multiple evaporator system models more perfect, so that the students can have more knowledge about multi evaporator material.
- 3) It is best for the teacher/lecturer to try making the educational medium themselves, including the trainer unit, so that it facilitates the usage in the teaching process or teaching/learning process, and to get a relatively cheap visual display in the economic crisis condition nowadays.

BIBLIOGRAPHY LIST

Abdulhak, Ishak. 2003. Media pembelajaran dan peranannya dalam meningkatkan mutu pendidikan (tinjauan paedagogi). *Makalah* pada Pelatihan Pembuatan

Media Pembelajaran Jurusan Pendidikan Teknik Mesin. Bandung. JPTM
FPTK UPI.

Blank, E, William. 1982. *Handbook for developing competency-based training programs*. New Jersey. Prentice-Hall, Inc.

Bower, H, Gordon., Hilgard, R, Ernest. 1981. *Theories of learning, fifth edition*. Englewood Cliffs, N.J. Prentice-Hall/Inc.

Hasan, Syamsuri. dan Gunawan, Ricky. Februari 2006, Analisis Perakitan *Trainer Unit* Berdasarkan Aplikasi Konsep Refrigerasi pada Mata Kuliah Sistem Pendingin I. *Invotec Jurnal Pendidikan Teknologi Kejuruan*, Volume IV, Nomor 8. Hal 80-86.

Ibrahim, R. dan Syaodih. S, Nana. 2003. *Perencanaan pengajaran*. Jakarta. Penerbit PT. Rineka Cipta.

Ikhsan, Muhamad. 2006. [Teknologi Pendidikan](http://teknologipendidikan.wordpress.com/2006/03/21), Prinsip Pengembangan Media Pendidikan - Sebuah Pengantar. <http://teknologipendidikan.wordpress.com/2006/03/21>.

Muhtar, Muhamad. 2005. Pembelajaran kreatif. <http://www.pikiran-rakyat.Com/cetak/2005/1105/29/1106.htm>.

Mursell, J. dan Nasution, S. 2002. *Mengajar dengan sukses (successful teaching) edisi ke tiga*. Jakarta. Penerbit Bumi Aksara.

Nurdin, Fahmi., Gambut, Amran., Ridwan. 1982. Media pendidikan. *Makalah pada Semlok Metode Belajar Mengajar*. Padang. FKT IKIP Padang.

Sagala, Syaiful. 2005. *Konsep dan makna pembelajaran, cetakan ketiga*. Bandung. CV. Alfabeta.

Saran, Y (Director)., 1982. *Aspects of curriculum for technician education*. Singapore. Colombo Plan Staff College for Technician Education.

Sarao, A.S. dan Gaabi, P.S. 2001. *Refrigeration & air conditioning second edition*. New Delhi. Satya Prakashan.

Sudjana, Nana. dan Rivai, Ahmad. 2001. *Media pengajaran cetakan ke empat*. Bandung. Sinar Baru Algensindo Offset.

-----, 2003. *Teknologi pengajaran cetakan ke empat*. Bandung. Sinar Baru Algensindo Offset.

Suyanto. 2005. "Kompetensi guru kejuruan" berdasarkan tuntutan kompetensi lulusan SMK. *Makalah* pada Seminar Nasional Standar Pendidik Bidang Pendidikan Teknologi dan Kejuruan Menurut PP. Nomor 19/2005 (Kualifikasi, Kompetensi, dan Sertifikasi). Bandung. Fakultas Pendidikan Teknologi dan Kejuruan Universitas Pendidikan Indonesia.

Syaodih S., Nana. 2001. *Pengembangan kurikulum pendidikan dan pelatihan teknik*. Bandung. UPI.

----- . 2003. Penyusunan handout dan modul. *Makalah*. Bandung. Program Semi QUE Jurusan Pendidikan Teknik Mesin FPTK – UPI.

Tola, Burhanuddin dan Munawar, Wahid. 2002. Penilaian hasil belajar. *Makalah* pada Seminar dan Lokakarya Instrumen Akuntabilitas Proses Belajar Mengajar. Bandung. Fakultas Pendidikan Teknologi dan Kejuruan Universitas Pendidikan Indonesia.