Mechanical Technology Department

Refrigeration & Air-conditioning

An investigation into the viability of using Variable Speed Drives in the HVAC industry in Saudi Arabia

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What is the Quran's perspective on waste and extravagance?

" Islam is a religion which has set forth a program for every facet of human life and has advised balance and moderation to its followers in all affairs. Islam has set the legitimate enjoyment of divine blessings as permissible and it has also set waste and extravagance as being impermissible. These limits have been set for the reason that all Muslims, in light of their social positions and wealth, have a responsibility towards the human society in which they live. If people were to be wasteful and extravagant, they would be harming that society and shirking their human responsibilities; in addition, they would develop and cultivate negative personal characteristics which would be destructive to them on an individual level. In order to fully understand the subject of waste (Tabdheer) and extravagance (Israaf), it is first necessary to explain these two terms and then delve into the various facets of this issue in light of the teachings and precepts of Islam.

The Harms of Israaf for the individual

1- Physical harm to the body: exceeding the limits in eating and drinking bring great harm to the body. The Quran also warns the believers against israaf in eating and drinking: ' كُلُوا وَ اشْرَبُوا وَ لا تُسْرِفُوا، إِنَّهُ لا يحِبُّ الْمُسْرِفِين', which means: '… eat and drink, but do not waste; indeed He does not like the wasteful.'[1][1]

2- The wrath of God: 'انه لايحب المسرفين'[2][2], which means: 'God does not love those who do israaf'. Imam Sadiq (a) has said the following in regards to israaf: 'ان السرف امر يبغضه الله'[3] [3], which means: 'Israaf is subject to God's wrath.'

3- A decrease in blessings: Israaf causes the blessings to decrease in one's life and to eventually die out completely: 'إِنَّ مَعَ الاسْرافِ قِلَّةَ الْبَرَكَةِ',[15][4] which means: Israaf comes hand in hand with a decrease in the blessings."

[1] Surah A'raaf, Verse 31.
[2] Surah An'aam, Verse 14.
[3] Kāfī, vol. 7, p. 339.
[4] Kafi, vol. 4, p. 55.

Reference

Islamquest. 9-5-2012 . islamquest.net

Acknowledgment

The completion of this study could not have been possible without the assistance of many people. Their contribution and support are appreciated. The researcher express his deep appreciation to the following:

Mr. John Smartt for his support and boundless help.

Mr. Brian Staines for his support and boundless help.

Students Name. Hani Maustafa Ali Kurdi .

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Abstract summary

In this thesis I aim to research the use of "Variable Speed Drives" in refrigeration and HVAC equipment and create/develop a learning module based on my findings. I will research the use of VSD devices as I feel that it is vitally important that as a teacher in the field of RAC I am up to date with all of the innovations and new equipment available on the market.

The purpose of my lesson on variable speed drives will be to develop the students understanding of how to reduce running costs by using Variable Speed Drives (VSD) in refrigeration. Students will fill out the survey and the results will be used to do some compilation tasks and to write a short report.

Chapter 1:
Project Proposal

1. Title

   An investigation into the advantages of using a variable speed drive on compressors and fan motors in the HVAC industry.

2. Introduction

   It is a well-known fact that he temperature of the weather in Saudi Arabia can become extremely hot in the summer which has the effect of increasing the consumption of electricity due to the air-conditioning systems working constantly to cool the inside of the buildings, this in turn increases the consumption of the petroleum products and thus an increase in CO^2 output from the Power Stations. This continuous operation of the refrigeration components in these air-conditioning systems can result in serious damage and it leads to an increase in global warming.

   By installing variable speed drives in these systems the rate of rotation of the electric motors involved can be controlled. Another use of VSD's is to help us conserve energy and enhance the efficiency. The variable speed drive has the effect of reducing the amount of electricity the motor consumes, while at the same time increasing the efficiency of the electric motor.
   Typically in an average building in the KSA about 72% of electrical consumption is due to refrigeration plant with the compressor and fan motor being responsible for up to 63% of that, therefore the opportunity to save energy is high if we use a VSD drive on the system. Additionally it can have the beneficial effect of decreasing the amount of sound given off by the compressor and fan motors.

   The variable speed drive is suitable for use in refrigeration and air-conditioning systems and can also be applied in manufacturing plants and factories in industry. The Variable Speed Drive can also be used to control the pumps and fans in a hydronic heating system as well as to control domestic refrigerators, freezers and air-conditioning units.
   Finally I will also investigate the cost of these devices over the past five years.

   * Purpose

     To investigate the advantages of installing a variable speed drive device on compressor fan motors in the Heating, Ventilating and Air-conditioning industries.
   * To solve the problem of how to reduce the consumption of electrical energy in the HVAC industry.

3. Project questions

   The main question posed by my project is;

How to integrate Variable Speed Drives into the Refrigeration and Air-conditioning equipment installed by the HVAC industry in the Saudi Arabia, in order to reduce the consumption of electrical energy .

4. Project methodology
    - Method: I will carry out research on Variable Speed Drives in a number of industries and analyze the results.
    - Tools: Research, Analysis , research by book or website and the analyse the technique I use it to collect the date.
    - Statistical method: By a survey .
      Research: Try to discover new information on the applications and installations for Variable Speed Drives.

5. Project limitation :
    - Data will be collected through books & websites
    - The development the applications for Variable Speed Drives
6. Project terms :
    - Define a new learning course for Variable Speed Drives
    - Define the cost savings in electrical energy by installing Variable Speed Drives
    - Define the new applications for Variable Speed Drives
7. Expected results:

   The study aims to provide the TTC students with easily accessible and user friendly information on Variable Speed Drives as a resource for their studies.

8. Project milestone :

Select a topic Thesis registration and topic submission	6,13.10.2016
Writing a study proposal	20.10.2016
Writing a literature review	03.11.2016
Data collection	17.11.2016
Writing the results and discussion	01.12.2016
Final manuscript	22.12.2016
Submission of thesis	29.12.2016
Submission of final mark / Final evaluation and colloquia	12.01.2017
Graduation	26.01.2017

The structure:

The structure of my project is an E-Learning Course:

- An E-Learning solution for the TTC students
- Development of an E-Course for the TTC students
- E-Course as a new direction for learning online
- Develop individual learning modules
- Knowledge skills, competencies and understanding in their vocational discipline
- Ability to apply knowledge and understanding
- Communication skills
- Learning skills
- Social and personal competencies. [5]

[5] Accreditation Report of TTC . ZEVA – Zentrale Evaluations.und . 2011

Quoting session:

Vocational Pedagogy (Developing an E-Course) :

- E-Learning solution for TTC students
- Development of E-Course for TTC students

In this project I will design individual modules for the students undertaking the course. The course will be designed for individual learning. Students are expected to enrol into the course and go for learning based on individual needs. Once students complete the course, he/she will be asked to do an examination online. In order to start designing the course, researcher will follow these steps as Keser &Karahova (2010) did[6] [7]

In order to support the students and following tasks will be considered for success of this E-course project.

1) Defining the curriculum and scheduling E-course activities,

2) Defining the goals and sub goals with gaining of e-course by using Bloom Taxonomy,

3) Designing scenarios and interactive animations for e-course unites.

4) Designing interactive cognitive maps,

5) Preparing quizzes for assessing learning of concepts and operational knowledge of e-course unites,

6) Student manual designing for teaching e-course activities systematically,

7) Arranging a debate forum to students for making discussions for solutions of different case studies,

8) Creating cross word puzzles to support learning retention

9) Designing an infrastructure to present both synchronous and asynchronous.

10) Surveying learning confusions, false-lack learning topics of project management courses by analyzing

11) By using benchmarks from previous course results, course topics, activities and scenarios will be created,

12) Designing scenarios for fundamental activities that planned to learned in each unites,

[6] Keser &Karahova (2010). Designing a project management e-course by using project based learning, Procedia Social and Behavioral Sciences 2

[7] semradova I (2011).Designing E- learning and their use in the interuniversity study programmes , procedia computer science

13) By regarding learning styles (Felder-Silverman, Felder-Solomon) of students designing content flow and

sequence of learning tools,

14) To determine contribution of different activities on learning, evaluation studies will be implemented on scenario based hypothesis,

15) Students who gets project management course in class and E-class are evaluated by the same final exam to **Bachelor thesis guidelines for Students Dr. Bahaaeldin Mohamed** benchmark the advantages,

16) Students' needs and expectations will be determined depending on end user evaluation tests in course coverage,

17) Cognitive overloads will be measured for end users,

18) E-reading speeds will be measured for end users,

19) Capacity of visual item perception in e-learning environment will be measured for end users,

20) Short and long term memory capacities will be measured for end users, (testing method

21) Critical thinking and collaborative learning **surveys** will be implemented to the students,

22) Collecting and analyzing data of end user usability evaluations and system performance,

23) Implementing system usability tests for course design,

24) Determining evaluation metrics for different e-course modules' learning activities,

25) Creating reports for marks of all activities in different unites as a students' transcript in e-course system,

26) Creating reports for the attendance of each students on the MIS system,

27) Developing interactive project development tool to like a wizard to help students for different project management reports (project requirements analysis, progress reports, design reports, test reports, etc.),

28) Proposing different project management topics for students and putting the milestones for the important tasks.

Chapter 2:
Method

There are many different ways or techniques used in education to teach, these are traditional education, group education and scientific research. However I want to design an E– course (Electronic course) on the website so that this E – course will be a new way in education and it is a very useful way for both the teachers and the students.

At the moment they are many different ways to teach such as; Distance Learning, Practical Training Courses, Educational videos, etc. The E-course it an educational program and it includes the following: The Lesson, Homework, Educational videos, and the exercises.

Project method

I will use many diverse ways to deliver the E-course in my project entitled "Variable Speed Drives" using the following techniques:

- What is a Variable Speed Drive?
- What are the benefits of the Variable Speed Drive?
- How does the Variable Speed Drive work?
- Where are the Variable Speed Drives used?
- What types of Variable Speed Drives are there?
- How to calculate the Variable Speed Drive?
- The statistics of the Variable Speed Drives in Saudi Arabia.
- What are the applications of Variable Speed Drives in the refrigeration and air conditioning systems?

I will include all of these topics on my course on the website and let the students choose which topics contribute to their development so that they can progress faster through the course. I will also put the homework and exercises for each lesson on the website of the course the tests or examinations will also be on the website too.

All of this information is designed to let the students see for themselves their level of attainment during the course and also to indicate to them any gaps in their knowledge or mistakes, the website will help them to locate the correct information by themselves. The examination, which will be indicated by a symbol on the website, will permit the students to take the examination when they themselves feel ready for it. This means that the teacher will not be wasting time on setting and correction examinations for his students.

The E-course is considered important for both the teacher and the students, due to the availability of the material on the web at any time, which means the students can study at their convenience. However the teacher has control of the teaching

and the students are closely monitored. For the students it will be very important for them and it will help to avoid the pressure of school and study.

Research methodology

In my project entitled "Variable Speed Drives" I will use many different techniques, such as; Books, The Library, Websites, Educational video, and finely the PDF file, all of these are part of my research methodology, my project is one based on practical research and the student survey will also form part of the practical research. The survey is a good method to obtain some information and along with the questionnaires they will let me get the information that I want, as well as the interviews, observations and the discussion group all of these will let me know more and more about what I want to research.

Research tool

The research tool is so import to help me to write this project thesis and also to let me know how to design the E-course. Therefore the correct research tool is key to letting me get to the information in the quickest time and it also gives me more time to find the specific information which I require. I also use writing paper to take notes when I find good and relevant information for my project and when I get back to my home I will analysis this new information before typing it on the word programme.

I also visited two of my lecturers; Dr. Brian Staines and Dr. Bahaaeldin Khairy Mohamed, who provided me with more information about research methods and the tools used to carry it out. The final thing I did was the survey, this tool is very useful for me because I was able to collect the data from the students with little effort and having obtained the answers I analysed the results of the survey for my project.

Data collection

As I mentioned previously I have used a student survey to collect the data which I required for my thesis. I used the information from the student survey to design the content of the E-Learning course. From the information which I extracted from the survey questions I will include, in my E-Learning course the following information; Tutorials, Educational Videos, Homework Exercises, Examinations.

All of this information will be accessible on my dedicated website.

The following are the questions which I asked in my survey of the students:

1-How old are you?
2- What is you major?

3- Where do you live in Saudi Arabia?
4- Would you like to see Power Point slides during the lesson?
5- Would you like to see Videos during the lesson?
6- Would you prefer the lesson, homework and examination on the website?
7- Would you like to be able to evaluate the lesson on the website?

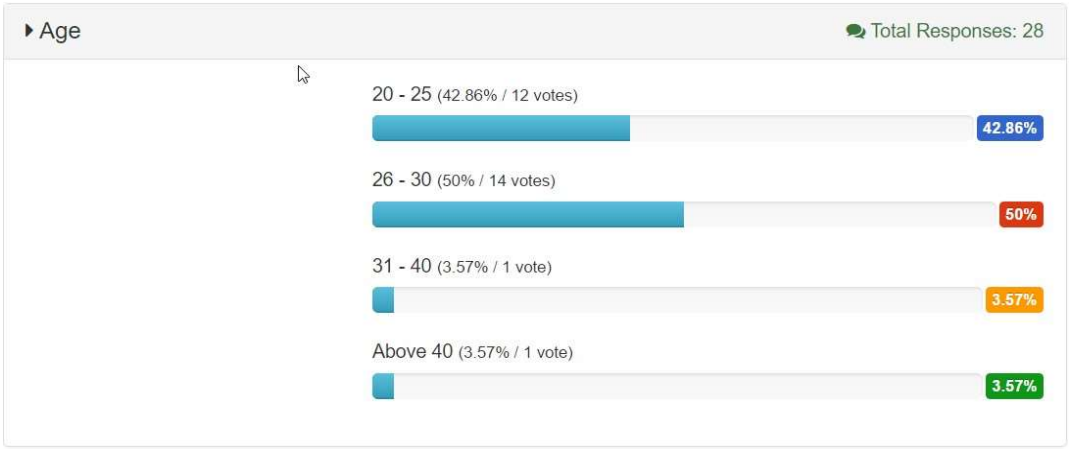
These are the questions which I asked on my student survey, after the students completed the survey, I analysed the results and these are outlined in Chapter 3.

Chapter 3:

Survey Results:

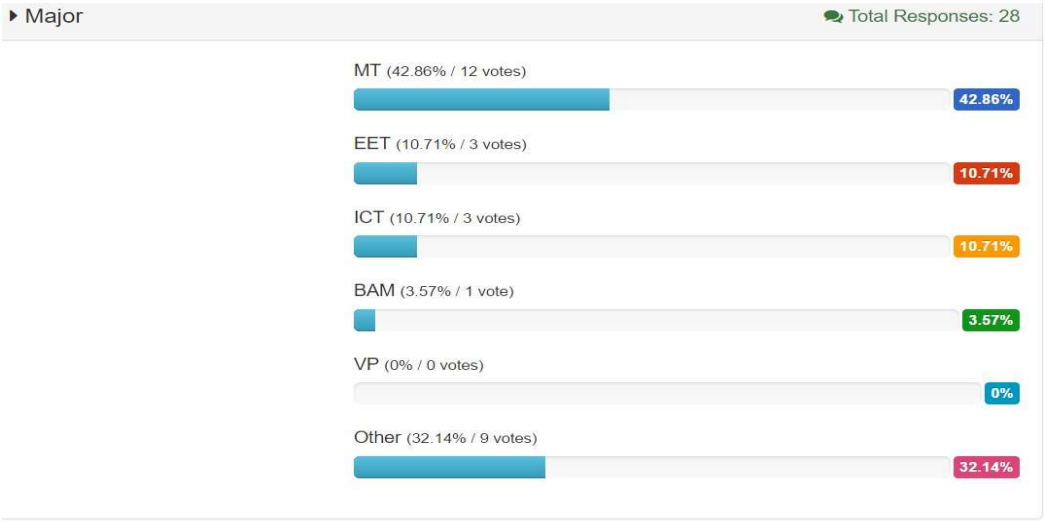
I got the results of my survey from 28 student responses and the following is the analysis of these results.

Question 1. The age of the respondents.



The student responses indicate that most of them (50%) are between 26 – 30 years old. The second biggest group (42.86%) are between 20 – 25 years old.
The third group (3.57%) are between 31 – 40 years old.

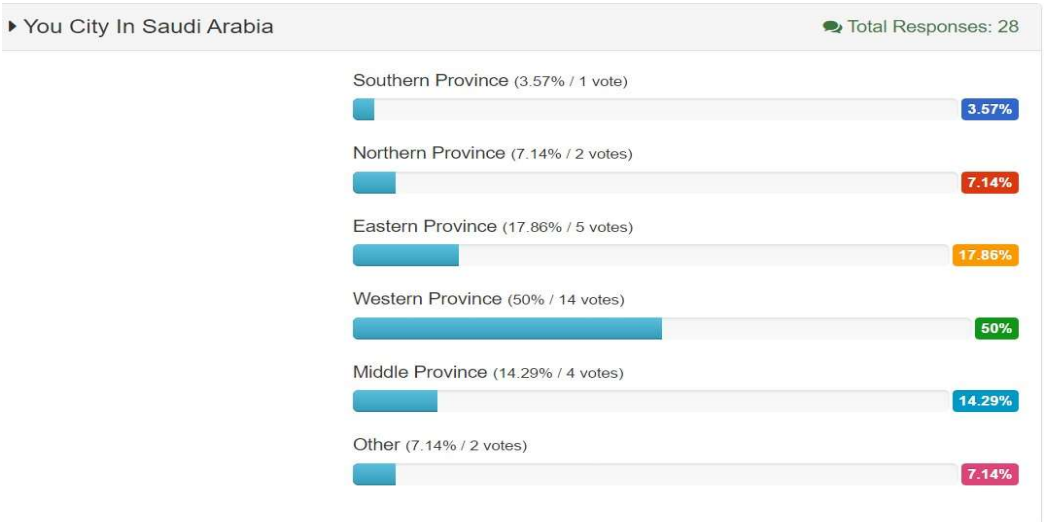
Question 2. The major of the students.



The student responses indicate that 12 of them (42.86%) were from the Mechanical Technology Department. The second biggest group 9 of them (32.41%) choose

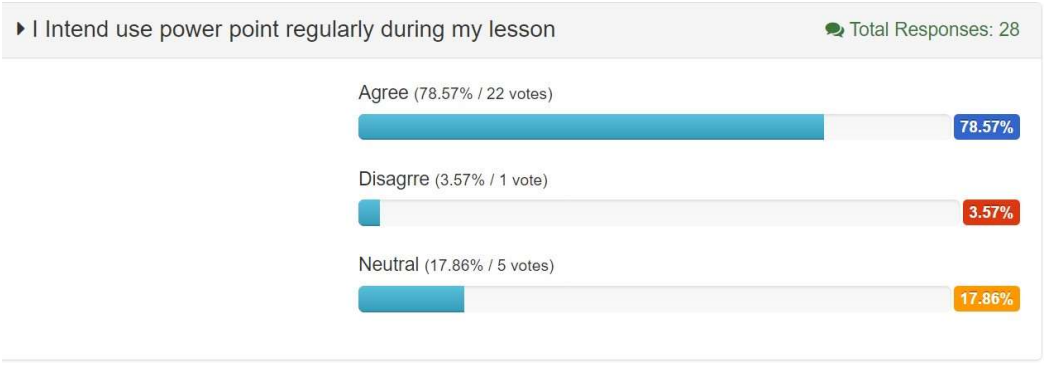
‘Other”. The third group was split between the Electrical Engineering Department, 3 of them (10.71%) and the Information and Communication Technology Department, 3 of them (10.71%). The Business Administration and Management Department had 1 of them (3.57%) and the Vocational Pedagogy Department had 0.

Question 3. The Saudi Arabian provinces where the students live.

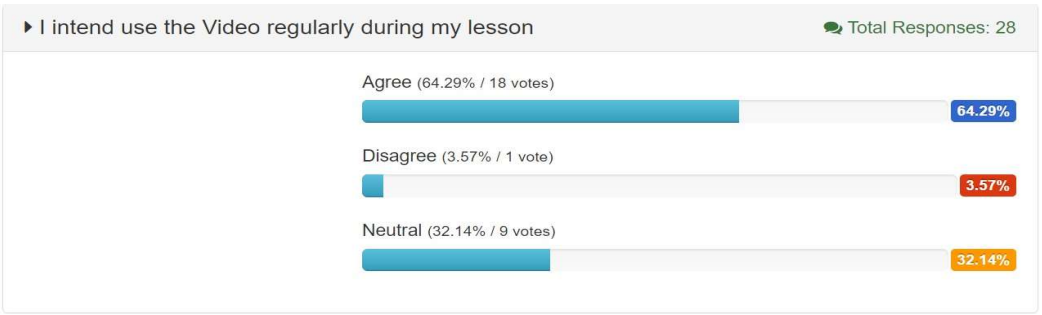


The biggest group 14 students (50%) come from the Western Province of Saudi Arabia. The second group 5 students (17.86%) came from the Eastern Province.
The third group 4 students (14.29%) came from the Middle Province.
The fourth and fifth groups 2 students each (7.14%) came from both the Southern Province and the Northern Province.

Question 4. The use of Power Point in the lesson.



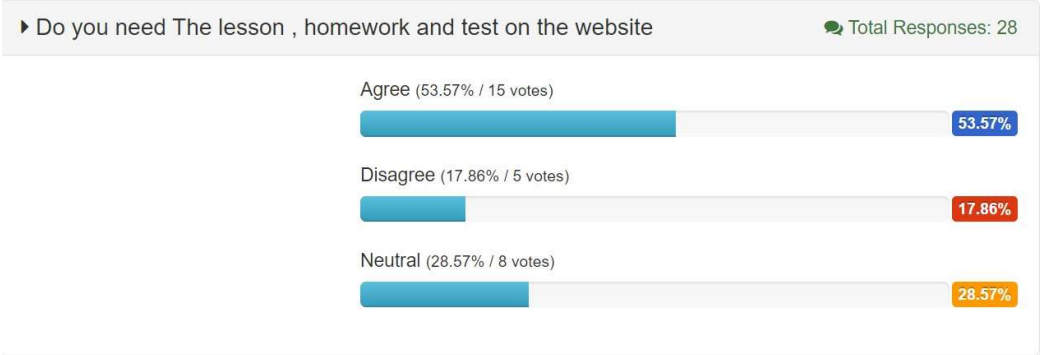
The biggest group 22 students (78.57%) agreed with the question. The next biggest group 5 students (127.86%) were neutral on the question and 1 student (3.57%) disagreed with the question.



Question 5. The use of Videos in the lesson.

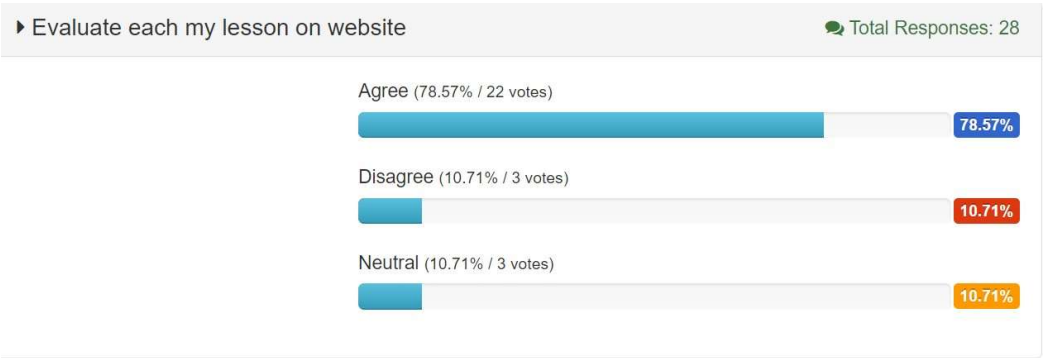
The biggest group of students 18 (64.29%) agreed with the question. The second biggest group 9 students (32.14%) were neutral on the question and 1 student (3.75%) disagreed with the question.

Question 6. The content of the website.



The biggest group of 15 students (53.57%) indicated that they would like this type of content on the website. The second biggest group 5 students (17.86%) were neutral on the question and 8 student (28%) disagreed with the question.

Question 7. The evaluation of my lesson.



The biggest group of 22 students (78.57%) agreed with the question. The second group of 3 students (10.71%) disagreed with the question and 3 students (10.71%) were neutral on this question.

Having finished the analysis of the results of my student survey, I discovered that the majority of the students prefer to see the lesson content

http://bzoor.com/index.php/surveys/11-ttc-students-survey/126-e-course-for-hani-kurdi-209

displayed on Power Point slides and Videos; therefore I will use these two media extensively in my E-Lesson on my website. Here is the code for my survey:

Experiment

The experiment of my design of an E-Learning course was a very useful experiment in my opinion. My reason for the design of this new E-Learning course is help the students to understand Variable Speed Drives. However, during the design process I have also learnt how to collect the data or information which I required from books, websites, technical publications, etc.

Design

The design of this course is important to the delivery of the lessons on the Variable Speed Drives. Listed below are the titles of the videos which are on my website.

Name of lesson	Methodology	Media
What is a Variable Speed Drive?	E-Course	Video
What are the types of Variable Speed Drives?	E-Course	Video
What are the applications for Variable Speed Drives	E-Course	Video

Chapter 4

What are Variable Speed Drives?

A Variable speed drive is a device which controls the speed of a motor in order to increase its efficiency, reduce its running cost and match its output to suit requirements of a process.

What is the benefit of the Variable Speed Drive?

The benefits of the technology of the variable speed drives " VSD " are listed below:

- It changes the frequency from AC – AC to DC – AC. We know that AC means "Alternating Current" it is low current and we know that in the factories it necessitates more power from the electrical circuits.
- Governing the speed to improve output.
  This means the variable speed drive controls the speed of the motor and at the same time it improves the quality of the efficiency.
- Reduced noise when the motor runs at low speed.
  As we know the compressor and fan motor when it works it gives us more power, therefore the variable speed drives reduces the noise.
- It reduces damage to the motor.
  Many factories suffer from damage motors, so the variable speed drives, can reduce this damage.

- Reduces running costs.
  The variable speed drive can reduce costs because if it weren't fitted then there would be an increase in the electricity and fuel used.
- Makes the compressor and fan motor more energy saving, higher efficiency and at the same time it lowers the motor noise. We know that the compressor, fan motor, refrigeration and air conditioning system can be noisy, however the variable speed drive can reduce this.
- It provides good control of the motor output.
  This means it can control the speed of the machine when it is running fast or slow, it must permit the motor to accelerate safety to keep the variable speed drive free from damage.
- Variable speed drive machines protect the compressor, fan motor and the other parts from the redundant electric charges.

How the Variable Speed Drives parts work.

In this section I will explain how the parts of the variable speed drive operate.

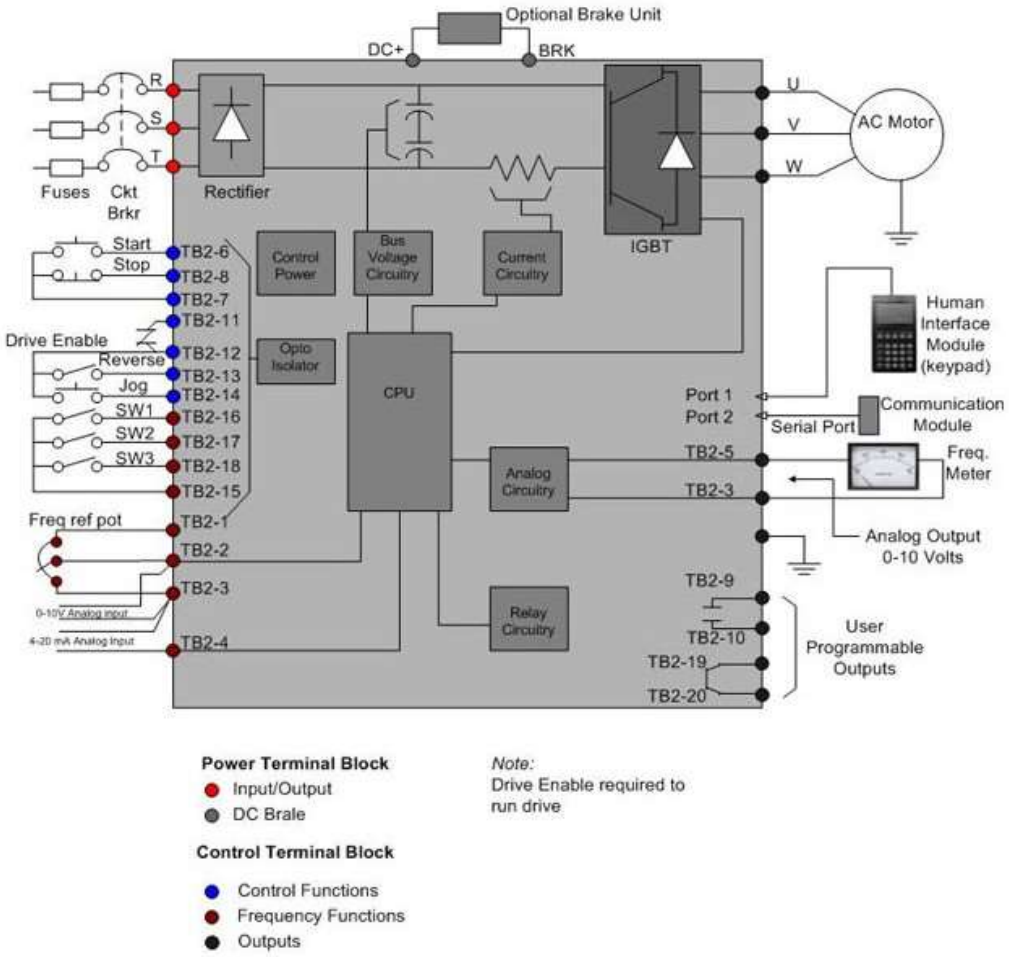


Figure 1. A drawing of the Variable Speed Drive components

As you can see Figure 1. shows the main parts of Variable Speed Drive, there are 10 general components which are shown and named on the illustration. The first part is called the “CPU” which is an abbreviation for (i) “The Central Processing Unit”, (ii) The Current Circuitry, (iii) Optional Brake Unit , (iv) Analog Circuitry, (v) Relay Circuitry, (vi) BUS Voltage Circuitry,(vii) Control Power , (viii) Opto Isolator, (iv) Rectifier, (x) IGBT which is an abbreviation for the “Insulated Gate Bipolar Transistor”.

1. CPU " Central Processing Unit "
   The CPU is the part which has the information on the programing of the Variable Speed Drive, this part does the controlling of the speed of the motor and it raises the efficiency of the compressor and fan motors in the refrigeration and air conditioning system.
2. Current Circuitry
   This part receives the signal from the CPU and it uses that signal to change the current before the IGBT.
3. Optional Brake Unit
   In this section the Optional Brake Unit is installed and it controls the current entering the motor.
4. Analogue Circuitry
   The analogue circuitry receives its command signal from the CPU, it also allows the current to pass through the frequency meter which provides a reading of the supply frequency.
5. Relay Circuitry
   The relay circuitry is the switch which protects against high current entering the CPU circuitry.
6. BUS Voltage Circuitry
   BUS Voltage Circuitry is the part that receives the signal from the CPU to decrease the noise of the higher electric current from the rectifier.
7. Control Power
   Control Power is the part controls the energy monitoring and so this controls the performance of the Variable Speed Drive.
8. Optical isolator "Opto isolator"
   The name of this part is the Optical isolator and its function is to transfer the signal of the electricity between the electrical circuits isolated by the light.
9. Rectifier
   The purpose of the Rectifier is to rectify the alternative current AC to direct current DC.
10. IGBT " Insulated Gate Bipolar Transistor "
    This part is used in the high current area and its function is to prevent the reception of the high current by another part and it Includes features such as a fast adapter to current and also has the ability to prove the other electrical circuits.

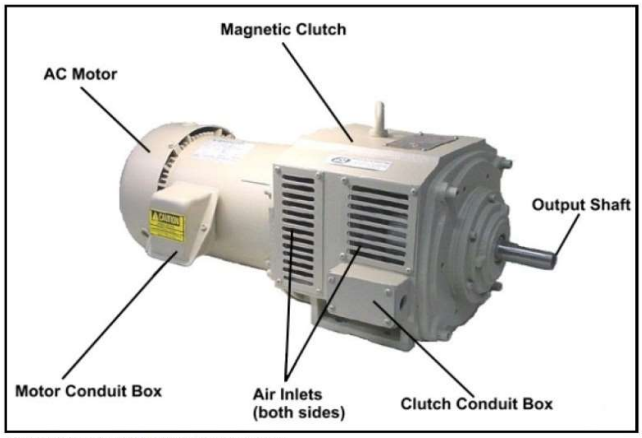
Where the Variable Speed Drives are used

1. Heating equipment and refrigeration and air conditioning systems. Specifically on the compressor , pumping , and fan motor

2. Food Industries.
   The food factories also use the Variable Speed Drives on machines for filling, packaging and on the production line.
3. Petrochemical industries.
   The petrochemical industries use the Variable Speed Drives on the distribution pumps , oil refining , fan motors , pumping ,
4. Metal Industries.
   The metal industries use Variable Speed Drives on smelting equipment to melt the metal, smelting furnaces, cooling metals.
5. Paper Industries.
   The paper factories use the Variable Speed Drives as it assists the equipment for chopping the paper , printers , cutting and peeling from the trees
6. Finally it is used in the factories as a tool or a machine on the motors of the production line.
7. And In the field of transport.
   Some transport companies they also use the Variable Speed Drives for the cranes to lift goods on to the back of the trucks.

What are the types of Variable Speed Drives?

The Variable Speed Drives has three types and each part has the features and specifications about frequency.
The first type is ….
- Eddy Current Drives



Typical Dynamatic DCD Adjustable Speed Drive

This part of motor type for variable speed drives and knowing that it consists form four general parts and this parts is: AC induction motor and magnetic clutch also the magnet have it have some part to help us to completion to function of variable speed drives and this parts is: input shaft, clutch coil, tachometer and the output shaft. This type will connect with digital control, so the digital control it send the signal to the motor to control the speed of motor. When we want to lower and raise the speed of the motor is running it also moving the shaft of the motor this part is connected with the rotating drum , so we have the another important thing is small part and this part is named the bearing. As well as the bearing it connects between the drum and output rotor, between these two parts we have an air gap, the purpose for it is to let the rotating drum movement by the good way. The other components of the magnetic clutch art the clutch coil,

tachometer and the output bearing. When the rotating drum is starting to work and this part for AC motor, at the same time the output clutch rotor with a shaft because it gets a signal from the digital control at that moment the magnetic flux is also working, when the rotating drum and output clutch rotor and the same speed the magnetic flux is absorbed and reducing speed of the motor by the rotating drum. The tachometer is also connected to the digital control so the process of it is to then sends the feedback to the digital control to let us make sure that the system is working well or it has a fault.

The second type of VSD is:

- DC Drives:

The DC drive is another type of the Variable Speed Drives and the specifications of it is to change it speed smoothly and at the same time it keeps changing the speed of the motor. The DC drive can change between the maximum speed and the minimum speed also for the acceleration and deceleration. As well as fix it if the system got some problems for the speed. DC drive it doesn't change the voltage or the current when we press the bottom ON/OFF , however the DC drive can receive high voltage so it can also protect and manage all components of the system.

The third type of VSD is:

- AC Drives:

The AC drive type is an advanced one because the DC drive is a traditional system. Furthermore the AC has got some of same functions as the DC system. The AC drive features for the monitor for the current and control for torque also the AC it extent of the limit speed and this feature is difference between the companies. AC drives it can let each parts on the system of the Variable Speed Drives some function and control for it. The AC drive is smart system, whereas that system it let us to download the programing to Variable Speed Drives and it let us to fix any problem or damage on the system.

Calculation of the Variable Speed Drives:

The calculation for the Variable Speed Drive must include the calculation of the speed of the motor and the torque of the motor. For this calculation exercise it is necessary to know the “RPM” speed of the motor and the RPM means "Revolutions per Minute" when we use the Variable Speed Drives, so we will need to know how to calculate both the speed and the torque of the motor.

Speed Of The Motor

Before starting to calculate the speed we must understand the other components. The first one is RPM this means "Revolution per Minute", the second one is 120 is a constant in the formula, the third one is F “Frequency" (In Cycles/Sec). The fourth one is P "Poles of Motor Winding"

The formula of the speed motor is

$$\text{RPM} = \frac{120 \times F}{P}$$

Example:

What is the revolution of the motor that has the 6 Poles connected to a 90Hz Power Supply?

$$\text{RPM} = \frac{120 \times F}{P}$$

$$\text{RPM} = \frac{120 \times 90}{6}$$

$$\text{RPM} = \frac{10800}{6} = 1800\ \text{RPM}$$

Calculating of the Torque

The torque is the force of the motor and how much of it generates when it rotates in the system of the Variable Speed Drives .Before starting the calculation we have some symbols we must know. "T" Torque symbols and the unit of it (in lb – ft). " F " Force, the unit of it (in lb). " D " is Distance, unit of it (in ft)

Example:

What is the torque is when the produced by the 90 lb and the force of it is 4 lever arm?

$$T = F \times \text{D}$$

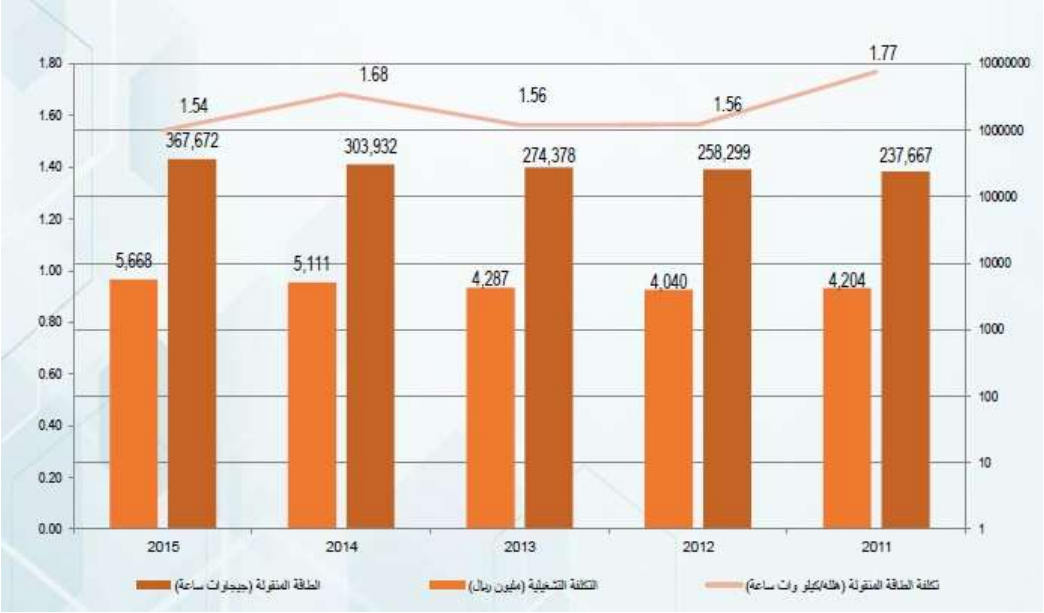
$$T = 90 \times 4$$

$$T = 360\ lb\ ft$$

Statistics of the Variable Speed Drives in the Saudi Arabia.

As we know Saudi Arabia has an area of 2.15 million square kilometers and this needs a lot of electric power coverage for all of the cities of the kingdom. To generate this electricity the electricity company consumes the mineral resources and utilizes oil to produce the electricity.

The production the power of the electricity is very expensive and it uses more mineral resources and oil and at the same time it is a threat to the future of the production of the electricity. For this reason it is worth considering the Variable Speed Drive as a system to reduce the consumption of the electricity p and help the companies that use a lot of electricity to save a lot of money, they can also increase the efficiency of the use of electricity.



Energy transmitted Operational cost Transmitted energy cost

As we see here on this chart is the cost commissioning payment from 2011 to 2015. we see three columns the first one is Energy transmitted by (Giga watt on hour) . The energy on 2011 it was 237,667 and the cost of it was 1250000, on the 2012 it was higher before and is got energy 258,299 by 1275000 million SAR.

In 2013 on three column is lower from 2012 and it got 1245000 million SAR. The last two column 2014 and 2015 bout of it arrival to thirty, the 2014 by

303,932 and it got 1280000 million SAR, however the 2015 it got 367,672 energy by 1283000 million SAR.

Operational cost on 2011,2012 and 2013 it probably got same indicator (4,204), (4,040), (4,287) of the operational , the three column the price of operational cost is could be 8,0000 .

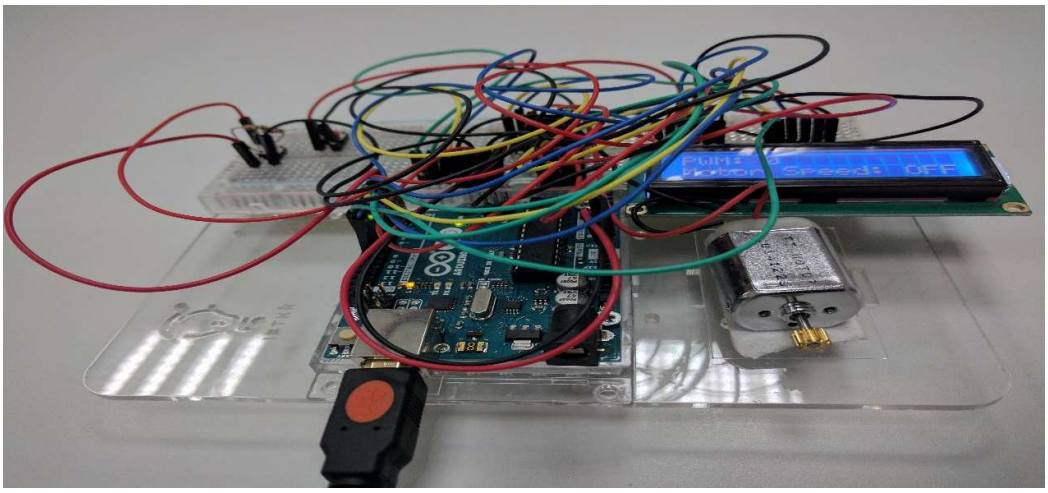
And the last two columns 2014 and 2015 both of it is higher indicator (5,111), (5,668), the price of operational cost is between 90,000 to 95,000 thousand SAR. Finally the transmitted energy cost and it estimated by (Halala and Kilowatt).

In this column is have many different thing about the cost on each years , in 2011 the cost it was 1,77 Halala of each kilowatt , and form 2012 the indicator of the cost is drop form 1,77 to 1,56 Halala of each kilowatt, in 2013 is the cost is stall constant price , in 2014 a sharp rise about the cost by 1,68 Halala of each kilowatt , on 2015 it was steep decline and the cost be 1,54 Halala of each kilowatt .

What is the use of the Variable Speed Drives in the refrigeration and air conditioning systems?

The refrigeration and air conditioning systems consume a lot of electricity in the provision of the refrigeration. For this the variable speed drive system can offer big saving in these type of systems about the costs of the electricity. The consumption of this electricity costs a lot of money in any one month and this is a problem if we don't use the variable speed drives. We must not forget the other useful quality of the variable speed drives system is that it allows the compressor and fan motor to run on the silent mode and at the same time it allows it to work and give us good efficiency. Even the cost of running the system is reduced because the compressor and fan are working a lot less and this means they consume less energy and that is a benefit to the company, as it saves them money. The variable speed drive system also assists the big companies, factors and the huge buildings and all of the places that need to use electricity to allow the systems of refrigeration and air conditioning operate without any problems and reduce their consumption of electricity .

Arduino Project



This project of the Arduino Project it the small project about the variable speed drives system, so I create that simple system to let the students to understand how the variable speed drives system work.

This project consists of the following parts:

1. Arduino part
2. DC Motor
3. Digital Variable Resistor IC
4. Resistance
5. Variable Resistor
6. LCD Screen
7. Wires
8. Board

The working model of the small project of the variable speed drive system is designed to control of the speed of the motor from the fast situation to the slow situation and vice versa.

Conclusion:

The variable speed drive is a useful system for us and for the big companies, and giant buildings. There are many different types of this system and each system has its own unique features. The variable speed drive system, which is electrically operated, is controlled by the programming and it is operated in order to save the high cost of electricity. As we know the bigger factories need a lot of electricity and the cost is high, so I analysed the chart of the statistics of the cost of electricity in Saudi Arabia from 2011 to 2016, whereas the variable speed drive is decreasing the higher costs and allows us to benefit from these savings in order to avoid these higher costs. However this system can also help us in the factories to reduce the costs when we manufacture goods. It can also help us to scale down the sizes of the compressors and the fan motors on the refrigeration and air conditioning systems and increase system efficiency.

I also created the website for the E-Learning course in order to share my lesson on the variable speed drive system, and this website includes all of the lessons, exercises, and the videos. The website also includes practice exercises so that the students can improve their knowledge of these systems i.e. the mathematical exercises for the calculation of the variable speed drive, this calculation enables the students to pick the correct motors for the system of variable speed drives.

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Appendixes

Survey of the student's attitude to the study will use the same survey as it was developed by

(Semradova .2011)

1. Course documentation was accessible and comprehensible.
2. The course objective was clearly formulated.
3. The tutor explained the course structure and its organization.
4. The tutor was able to strengthen my motivation for the course.
5. The learning material was well and systematically arranged and presented.
6. The methods used stimulated my study activity.
7. Self-study tasks were formulated unambiguously.
8. The tutor provided sufficient methodological instructions for self-study.
9. Requirements for the exam/credits were met and formulated unambiguously.
10. The tutor treated us fairly.
11. The tutor was interested in our opinions.
12. The course meant a reasonable load for me.
13. Unambiguous information on the interuniversity study programme project was provided in time.
14. The technical aspect meant no special burden for me.
15. The contingent technical problems were solved effectively and duly.
16. The obtained credits were acknowledged without problems at my home faculty.
17. There were no problems with signing up for the course in the Variable Speed Drives system.
18. The contingent problems with acknowledgement of the course were solved in time.
19. The studies within the frame of the project of the interuniversity study programme were beneficial to me
20. In the next academic year I´ll make use of this opportunity again.