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DIPLOMA PROJECT

DEVELOPMENT OF SPREADSHEETS FOR THE DESIGN OF MACHINE ELEMENTS

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Acknowledgment

I would to congratulate everybody who has contributed in the compute technology (software and hardware) that we can have and use, to make out life easier and more productive. Its amazing what you can do with a computer today.

Special thanks to my best friend Giorgos Heromeras for all his assistance with my project.

SUMMARY

Development of spreadsheets for the design of machine elements

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The aim of this project is to create spreadsheets for calculating different parameters of an engine, using MS EXCEL so as to evaluate its capabilities.

The first step is to get to know Excel, what it can and what it can not do, as a spreadsheet. The next step is to work with Visual Basic for Applications, so as to make the spreadsheet user friendly and productive.

The user of the spreadsheets produced is not required to know MS EXCEL. Just by following instructions, inputting different measurements, the spreadsheets display the results as: numbers in result forms, values on diagrams, charts and even as animations.

The equations and theory that was used in calculations was retrieved from different books (H.T.I. Mechanical Engineering syllabus and H.T.I. Library) and the MS EXCEL help files were indeed very helpful in building up the programs for the calculations.

Once you become familiar with the capabilities of MS EXCEL (and all other computer programs) you will wonder how you ever did without it.

INTRODUCTION

Heat engines can be classified as of the external combustion type or the internal combustion type. In an external combustion type the working fluid, which is producing power, is entirely separated from the fuel-air mixture, the heat of combustion being transferred through the walls of a containing vessel or a boiler. Examples of this type are the steam engine, the hot-air engine and the closed-cycle gas turbine.

In internal combustion engines the working fluid producing power consists of the products of combustion of the fuel-air mixture itself. This type includes the reciprocating petrol or diesel engine and the open-cycle gas turbine.

The internal combustion engine has the lower ratio of power-plant weight to maximum output and is used extensively in the field of transportation. Today the manufacture of internal combustion engines for automobiles, boats, ships, aeroplanes, trains and small industrial power units is one of the largest industries in the world.

Most of the internal combustion engines in use consist of a piston reciprocating in a cylinder. There are many types and arrangements of engines, and some classification is necessary to describe a particular engine adequately. The methods of classification are:

(a) By the fuel used and the way in which the combustion is initiated. Petrol engines and gas engines have spark ignition (S.I.). Diesel engines or oil engines have compression ignition (C.I.). In the S.I. engine the air and the fuel are mixed before compression and a spark initiates ignition. In the C.I. engine the air only is compressed and the fuel is injected into the air which is then at a sufficiently high temperature to initiate combustion.

(b) By the way the cycle of processes is arranged. This is defined by the number of complete strokes of the piston required for one complete cycle. The stroke of the piston is the distance it moves from the two extreme positions. There are referred to as *top dead center* and *bottom dead center*. An engine that requires four strokes of the piston (i.e. two revolutions of the crankshaft) to complete its cycle, is called a *four-stroke engine*. An engine that requires only two strokes (i.e. one revolution) is called a *two-stroke engine*.

The operation reciprocating piston types of internal combustion engines are based on either the Otto cycle or the limited-pressure Diesel cycle depending on the type of fuel the engine uses and the way the combustion is initiated. The spark ignition or the petrol engine operates on the Otto cycle; it uses petrol as a fuel and its combustion is initiated by a sparking plug. The compression ignition or the Diesel engine operates on the limited-pressure Diesel cycles; it uses Diesel oil and high pressures and temperatures initiate its ignition.

The analysis of the actual working cycles is rather complex because of the variety of parameters involved. In my spreadsheet the ideal air standard cycle, in which the working fluid is air, was used. The air standard cycle gives the maximum theoretical efficiency for an engine and provides a basis of comparison for the actual cycle.

The following assumptions are made when considering theoretical cycles.

1. An engine cylinder contains a constant amount of a working medium operating in a closed cycle. In actual conditions to carry out a cycle, the exhaust gases of the previous cycle must be removed from the engine cylinder and fresh working medium admitted. This process of gas exchange, disregarded in a theoretical cycle, requires the expenditure of work.

2. Heat is received from outside at a definite moment of the cycle in conformity with its nature. In actual cycles this heat is evolved as a result of a chemical reaction of the fuel with the oxygen of the air. This is a complicated combustion process, and the nature of heat evolution differs from that accepted in a theoretical cycle. Besides, the fuel is not oxidized completely at high combustion temperatures, thereby causing more heat losses.

3. The heat capacity of the working medium present in the cylinder is constant and does not depend on the temperature. Actually, the heat capacity is variable and depends on the change in the temperature and the composition of the working medium.

4. The processes of compression and expansion occur without, heat exchange with the environment (adiabatic processes). Actually, the considerable temperature difference between the working medium and the cylinder walls in both processes, as well as between the cylinder block head and the piston crown causes intensive heat exchange and the resultant loss of heat.

The utilization o heat in an engine is described by its efficiency, and its economical ratings by the amount of heat spent per unit of power.

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