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EXPERT KNOWLEDGE-BASED BOILER DIAGNOSING SYSTEM

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Laporan ini diserahkan kepada Fakulti Kejuruteraan Mekanikal
sebagai memenuhi sebahagian daripada syarat penganugerahan
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"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya"

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ABSTRACT

This project is on "Expert Knowledge-Based Boiler Diagnosing System" where a set of rules is created using Kappa-PC software to diagnose and provides solutions for fire tube and water tube boiler found in industries. This software contains main problems which are commonly found in boilers where solution is given for each of the problems. This is accomplished by the 48 rules created in this software. Before the rules are created, an in depth study and analysis is done on fire tube and water tube boiler to determine the various problems that usually occur in a boiler. The types and specification of the boiler is also determined. The rules for selection is created using Kappa-Pc software to make it easier for on inexperienced user to easily gain information and knowledge on problems faced in a boiler. This project covers the methods used in executing the Kappa-PC software and how a set of rules is created. The steps and criteria that are needed to create the rules are also explained.

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LIST OF FIGURES

LIST OF ABBREVIATIONS

SYMBOL	DEFINITION
mm	millimeter
Btu	British thermal unit.
hr	Hour
%	Percentage
°F	Fahrenheit
psig	Pressure square inches
hp	horsepower
ABMA	Fire Tube Engineering Guide
ASME	American Society of Mechanical Engineers
CRN	Canadian Registration Number
PTC	Power Test Code
CO	Carbon monoxide
AI	Artificial Intelligence
ANN	Artificial Neural Network
NN	Neural Network
GA	Genetic Algorithms
kappa	Kappa-PC
IES	Input Expert System
OES	Output Expert System
ES	Expert System
CE	Concurrent Engineering
KM	Knowledge Management
DM	Data Mining

ICT	Communication Technology
DT	Database Technology
VPN	Virtual Private Network
V	Volume
Mpa	Mega Pascal

CHAPTER 1

INTRODUCTION

Expert Knowledge-Based Boiler Diagnosing System

Expert knowledge-based boiler diagnosing system, which requires the development of an expert system shell. Before venturing any further, the definition and basic principle of boiler system is known. Boiler is equipment for generating steam. It is consists of two principle parts that the furnace which provides heat, usually by burning a fuel and the boiler proper which absorbs the heat and changes water into steam drum. The amount of steam that can be generated per hour depends upon the rate of combustion of the fuel in the furnace and upon the efficiency of the heat transfer to the boiler proper.

There are two most common types of steam boilers;

1. Fire tube boiler- It consists of the drum and tubes through which the hot gases from the furnace pass through. The water surrounding the tube external surface is heated up and changed to steam.

2. Water tube boiler – It consists of the drum and tubes in which the water circulates inside the tubes while hot gases heat up the tubes on the outer surface.

Factory and Machinery Act 1967 (Act 139) and Regulations 1972 give the definition of "Steam Boiler" is any closed vessel in which for any purpose steam is generated under pressure greater than atmospheric pressure. It includes all the mountings fitted to such vessel which remain wholly or partly under pressure when steam is shut-off.

1.1 Problem Statement

Boiler operation is a complex and requires years of experience to actually fully operate it. Thus skilled workforce with the necessary certificate such as certificate of competency that is issued by a qualified and recognized body is needed to run the boiler operation in industries.

Currently, industrial boiler does not fully utilize or does not have a complete expert system shell to diagnose the boiler problems. Some industries rely heavily on manpower to fully operate the boiler. There is no application of artificial intelligent that could simulate the human thinking in solving a particular problem relating to a boiler activity. The expert system shell could identify a particular problem using simulation and give recommendation to solve the problem promptly.

In the industries today, it is a time consuming affair and a lot of cost and manpower is needed just to identify the boiler problem or even its status. In some cases, there are boilers that do not achieve the optimum efficiency because the failure to diagnose the problem due to lack of knowledge. A boiler that does not fully utilize its capacity or has problems is detrimental to the environment where the combustion is not complete and the flue gas released contains hazardous material.

Expert system can greatly help improve this situation by preserving and disseminating the much needed expertise effectively at a reasonable cost. The usefulness of expert system in solving difficult practical problem is recognized and its development is pursued in various fields.

1.2 Objective of Study

1. To determine the application of boiler in industry.
2. To develop knowledge-based system using expert system shell to diagnose the problems of the boiler.
3. To create a data base which containing observations or evidence about a specific case, and all derived information about the case.

1.3 Scope of Study

1. To diagnose and solve the problem of industrial boiler
2. To execute Kappa-pc program to diagnose and to come up with solutions for industrial boiler.

CHAPTER 2

LITERATURE REVIEW

2.1 Classification of Boilers

Boilers can be classified in many ways and some of the ways are as follows :-

i. By Uses

a. Utility Boiler

To produce steam for electric power generation . Large capacity , high steam parameters , high boiler efficiency , completely water – cooled furnace with burners when pressure is greater than or equal to 14mpa usually with reheater.

b. Industrial boiler

To produce steam for heating and process, etc. Smaller capacity , lower steam parameters, furnace with burners, stokers or fluidized beds, no reheater.

c. Marine Boiler

As a source of motive power for ships. Compact general shape , lighter boiler weight , mostly fuel –oil fired , no reheater.

ii. By Steam – Water Circulation

a. Natural – circulation Boiler

The circulation of the working fluid in the evaporating tubes is produced by the difference in density between the steam – water mixture in the risers and water in the down comers. With one or two drums , can only operate at sub critical pressure.

b. Forced Multiple Circulation Boiler

The circulation of the working fluid in the evaporating tube is produced forcedly by means of a circulating pump included in the circulating circuit . With single drum or separators, can only operate at sub critical pressure.

c. Once –Through Boiler

No drum , the working fluid forcedly passes through the evaporating tubes only under the action of the feed-water pump , can operate at sub critical and supercritical pressure.

d. Combined – Circulation Boiler

There are a circulating pump ,a back – pressure valve , and a mixer in the circuit. At starting the back –pressure valve is opened and the boiler operates as a forced multiple- circulation boiler , on attaining the specified load , the circulating pump is switched off, the back-pressure valve is closed automatically , and the boiler operate at sub critical and supercritical pressure.

iii. By Pressure

a. Low-and middle pressure boiler (< 10 Mpa)

Used as industrial boiler, natural circulation , some with boiler bank , furnace with burners or with stockers, no reheater.

b. High Pressure Boiler (10 – 14 Mpa)

Used as utility boilers for large capacity once through or combined circulation, with reheater, the prevention of pseudo-film boiling and high temperature corrosion should be considered.

iv. By Fuel or Heat Sources

a. Solid Fuel or Heat Sources

Cost is mainly used : The component of fuel and the characteristic of ash are important influential factors for boiler design.

b. Fuel Oil Fired Boiler

With higher flue gas velocity and smaller furnace volume.

c. Gas Fired Boiler

Natural gas or blast –furnace gas are mainly used with higher flue gas velocity and smaller furnace volume.

d. Waste Heat boiler

Utilizing waste heat from industrial processes the heating sources.

v. By Firing Method

a. Boiler with stokers

Mainly used as utility boilers.

b. Boiler with Burners

Mainly used as utility boilers or large capacity industrial boilers.

c. Boiler with Cyclone Furnace

Applicable to coal having low slag viscosity and low iron content ;fuel is fired in a water –cooled cylinder , and the flame is whirled by either tangential coast dust-air jets from burners or tangential high speed jets of secondary air (80-120m/s); as is removed from the furnace in liquid form.

d. Boiler With Fludized Bed

Solid – fuel particles (1-6mm) are place onto a grate and blown from burners with an air flow at such a speed that the particles are lifter above the grate and are burned in suspending state ; used as industrial boilers for burning low-grade solid fuels.

vi. By Method Of Removing Slag In Furnace

a. Boiler With Dry Ash Furnace

Applicable to coals with high-ash fusion temperature; the ash removed from the hopper bottom of the furnace is solid and dry.

b. Dofer With Slag Tap Furnace

Liquid form aisg flows to the wet bottom of the furnace (a pool of liquid slag) and tapped into a slug tank containing water.

vii. By Boiler layout Form

Tower shape and inverted u-shape.

2.1.1 Natural-Water Circulation Boiler Versus Forced Multiple Circulation Boiler

1. No circulation pumps (hence no power consumption, pump failure concern.)
2. Can tolerate higher heat fluxes due to vertical tubes.
3. More real estate required.
4. Lesser supporting steel but more stack material.
5. tube wall temperature are more uniform around tube periphery and hence less thermal fatigue due to different heat transfer coefficients between steam and water, the top of horizontal tubes are hotter compared to vertical tubes.
6. Startup rates are a function of overall heat transfer coefficients, which is dependent on gas side flow, temperatures hence not much of a difference.

2.2 Firetube Boilers

The boiler is an energy conversion apparatus that takes in fuel, air and water in the right proportion and produces hot gases, steam and radiant heat. The hot gases are allowed to escape up the chimney when as much useful heat has been extracted from it. The radiant heat lost is kept to a minimum by the insulation around the boiler. Steam is the only usable portion of the process.

Boilers in the industry are the nerve centre of the operation and its well being is of utmost importance. Boilers that generate steam are used in the industry for the following functions:

1. Heating
2. Drying