



Work package 1.05

Study guide

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Development and use

This course was developed by UGM team that has the following members:

1. Samsul Kamal (samsul@ugm.ac.id)
2. Khasani (khasani@ugm.ac.id)
3. Fauzun (fauzun71@ugm.ac.id)
4. Hari Agung Yuniarto (h.a.yuniarto@ugm.ac.id)

With contribution of :

1. Kees van den Ende (kees.vandenende@dnvgl.com)
2. Theo van der Meer (UT)

The potential, final users of these course materials are those who already graduated from undergraduate level with the background study of engineering and science, for both fresh graduates and ones who already involved in the geothermal related works.

Abstract

One of the problems during the exploitation stage of geothermal development is how to maintain the output of the resource. It is a natural situation when there is an output decline during the development due to the fluid extraction. However, a significant decline of the output can be observed for many fields around the world. The possible causes of the decline can be from subsurface condition and/or upper-surface facilities. Most of the problems found in the upper-surface facilities is caused by the lack of understanding on the behavior of the field, operation and maintenance activities of the power plant. Therefore, the understanding on the above subjects is very important. Based on the above conditions, the main of the course consists of basic knowledge, geothermal equipment plant, Reliability Centered Maintenance (RCM) in geothermal power plant.

Target group

The target groups of course are practitioners, trainers/ lecturers. To attend this course, the entry level of the participants should be graduated from under graduated level or have experiences in geothermal related works.

Content

The course content is designed as follows;

- I. Basic knowledge
 - a. Fluid mechanics (Basic fluid mechanics, Single and Two-phase flow in pipe)
 - b. Thermodynamics (Geothermal cycles, Energy & Exergy)
 - c. Heat transfer
 - d. Mass transfer, psychrometry, moisture transfer
- II. Geothermal equipment plant
 - a. Wellhead (valves, blowout preventer and control, etc.)
 - b. Separation (separator, flasher, water collecting tank, etc.)

- c. Transmission (steam, two-phase and brine pipelines, condensate trap, expansion loop, support, demister, moisture remover, rock muffler, etc.)
- d. Utilisation (turbine, generator, condenser, control, lubricating oil system, air compressor, condensate pump and motor, etc.)
- e. Heat and geofluid disposals (gas removal, scrubber, water cooling tower, cooling water pump, injection pump, injection well, spray ponds, etc.)

III. Reliability Centered Maintenance (RCM) in geothermal power plant

- a. Introduction to RCM
- b. Failure modes & effect analysis
- c. Proactive maintenance (prevention & prediction)
- d. Failure finding
- e. RCM decision analysis
- f. RCM process & implementation
- g. RCM archives

Learning outcomes

After completing the series of this course, the participants are expected:

- To understand the implementation of basic concept of Fluid Mechanics, Thermodynamics and Heat Transfer in geothermal equipment including both in fluid gathering system and power plant.
- To analyze and to solve the problems in Fluid Mechanics, Thermodynamics and Heat Transfer in geothermal equipment including both in fluid gathering system and power plant.
- To understand the equipment used in fluid gathering system and power plant including name, components/parts, function, related equation and the general design of the equipment.
- To understand the concept and principles of Reliability Centered Maintenance (RCM).
- To understand the concept of proactive maintenance.
- To understand the steps of implementation of RCM.
- To be able to establish RCM information sheet, e.g. the list of functional failure, failure mode, failure effect for geothermal components facility.

Study load

Study load is defined as the amount of time needed by the student or participant to study the course. This includes all activities: self-study, following lectures, conducting assignments, practicals, field work, etc. Please fill in the following table:

Activity	Number of hours
Self-study of the materials and the assignments	12
Lectures	35
Supervised practicals	-
Project based learning	-
Preparation for assessment	6
Field work/trip	7
Total	60

Course structure

The study load is spread in time as shown in the following timetable.

Main Topic	Sub Topic	Day-					
		1	2	3	4	5	6
Basics	Fluid Mechanics	■					
	Thermodynamics/Heat Transfer	■					
	Mass Transfer	■					
Geothermal Equipment Plant	Wellhead	■					
	Separation		■				
	Transmission		■				
	Utilisation		■				
	Disposal		■				
Reliability Centered Maintenance	Introduction to RCM			■			
	Failure Modes & Effect Analysis			■			
	Proactive Maintenance			■			
	Failure Finding				■		
	RCM Decision Analysis				■		
	RCM Process & Implementation					■	
	RCM Archives					■	
Field trip	Field trip to the nearest geothermal power plant						■

Teaching and learning methods

Learning and teaching methods are:

- Lecture
- Individual assignment

All these activities are conducted in a face to face setting in the class room and/or the field.

Assessment

The assessment formats are taken as:

- Assignment
- Presentation

Study materials

The study materials used in the course are:

- Books
- Articles
- Hand-outs
- Assignments
- Self-tests

Teaching materials

The teaching materials available for teaching this course.

- Power point
- Exams