

## Training modules for geothermal technicians for use by technical colleges

### I. Main Objective

The modules made to improve the basic knowledge of technicians and operators in operating geothermal power plants. The modules focused on a single flash steam power plant and piping design for geothermal.

### II. Involved Personnels:

Module writers	Advisors
<ul style="list-style-type: none"><li>• Agastyo Nugroho</li><li>• Dimas Taha</li><li>• Candra Mecca S.</li></ul>	<ul style="list-style-type: none"><li>• Dr. Abdurrachim</li><li>• Ir. M. Ali Ashat, Dipl-eng</li></ul>

### III. Module Syllabus

The module consists of 16 sections & practice, namely:

#### Chapter A: Introduction

- TECH 801 – Geothermal System
- TECH 802 – Utilization of Geothermal Energy
- TECH 803 – Production of Geothermal Reservoir

#### Chapter B: Production Facilities

- TECH 804 – Fluid Mechanics & Flowmeter
- TECH 805 – Pressure & Temperature gauges, Well head, Silencer & Rock Muffler, Steam Gathering System
- TECH 806 – Separator, Scrubber, Condensate/Steam Trap

#### Chapter C: Piping

- TECH 807 – Heat Transfer
- TECH 808 – Fluid pipes, Heat Insulator, Pipe Supports
- TECH 809 – Fittings & Valves

#### Chapter D: Power Plant Facilities

- TECH 810 – Psychometrics & Cooling Tower
- TECH 811 – Demister & Strainer
- TECH 812 – Steam Turbine & Condenser
- TECH 813 – Gas Removal System
- TECH 814 – Main Cooling Water Pump, Blowdown Pump, Auxiliary System
- TECH 815 – Generator, Transformer, Switchyard

#### Chapter E: Safety, Health and Environment

- TECH 816 – SHE in geothermal industry

#### Calculation practice

- Practice 1 – Using of steam table
- Practice 2 – Thickness calculation and selection of heat insulator material
- Practice 3 – Simple method to analyze performance of single flash geothermal power plant system based on thermodynamics calculation

#### Details of Syllabus:

##### Syllabus Chapter A: Introduction

Topic		Geothermal System
<b>Code: TECH 801</b>		
<b>General Aim :</b> Students will have basic knowledge about geothermal system		
No	Students learn about:	Students learn to:
1	Geothermal Reservoir	<ul style="list-style-type: none"><li>• Understand about geothermal system</li><li>• Know how geothermal system was formed</li></ul>
2	Classification of Geothermal System	<ul style="list-style-type: none"><li>• Determine types of geothermal systems according to some experts</li></ul>
3	Hydrothermal System	<ul style="list-style-type: none"><li>• Identify hydrothermal system in geothermal area</li><li>• Describe components of hydrothermal system</li></ul>
4	Indonesia Geothermal System	<ul style="list-style-type: none"><li>• Recognize the types of Indonesia geothermal systems</li></ul>
5	Geothermal Manifestations	<ul style="list-style-type: none"><li>• Recognize the types of hydrothermal manifestations in geothermal field</li></ul>

Topic		Utilization of Geothermal Energy
<b>Code: TECH 802</b>		
<b>General Aim :</b>		
Students will understand direct-use and indirect-use of geothermal energy		
No	Students learn about:	Students learn to:
1	Classification of Geothermal Energy Utilization	<ul style="list-style-type: none"> <li>• Know the different between direct-use and indirect-use of geothermal energy</li> <li>• Use lindal chart to categorize geothermal energy source</li> </ul>
2	Direct-use of Geothermal Energy	<ul style="list-style-type: none"> <li>• Know the types of direct-use around the World</li> <li>• Know direct-use technologies that already applied in Indonesia</li> </ul>
3	Geothermal Power Plant Cycles	<ul style="list-style-type: none"> <li>• Recognize the types of GPP cycles</li> <li>• Understand of GPP cycle selection based on geothermal fluid's properties</li> </ul>

Topic		Production of Geothermal Reservoir
<b>Code: TECH 803</b>		
<b>General Aim :</b>		
Students will have basic knowledge about production of geothermal reservoir		
No	Students learn about:	Students learn to:
1	Fluid Properties	<ul style="list-style-type: none"> <li>• Understand about fluid properties (pressure, temperature, fluid density, viscosity, ph, fluid composition)</li> </ul>
2	Rock Properties	<ul style="list-style-type: none"> <li>• Understand about rock properties (porosity, permeability, Rock density, heat capacity, compressive strength, abrasivity)</li> </ul>
3	Mass and Heat Content	<ul style="list-style-type: none"> <li>• Understand about mass &amp; heat contents (enthalpy, entropy, saturation, conductivity)</li> <li>• Recognize how to use steam table</li> </ul>
4	Geothermal Well Testing	<ul style="list-style-type: none"> <li>• Recognize the types of geothermal well testing</li> </ul>

**Syllabus Chapter B: Production Facilities**

<b>Topic</b>		<b>Fluid Mechanics and Flowmeter</b>
<b>Code: TECH 804</b>		
<b>General Aim :</b>		
Students will understand how to apply fluid mechanics laws in operation of flowmeter		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Fluid Mechanics Laws for fluid flowing in pipe	<ul style="list-style-type: none"> <li>• Understand concept of Pascal’s law in hydrostatic pressure</li> <li>• Understand concept of mass and heat balance in volume control</li> <li>• Understand Darcy’s law and Bernoulli’s law</li> <li>• Understand concept of Reynold number to determine type of flow</li> <li>• Understand concept of pressure drop in pipe flow</li> </ul>
2	Flowmeter	<ul style="list-style-type: none"> <li>• Recognize the types of flowmeter</li> </ul>
3	Operation of Flowmeter	<ul style="list-style-type: none"> <li>• Understand working principles flowmeter</li> </ul>
4	Limitation and Accuration of flowmeter	<ul style="list-style-type: none"> <li>• Recognize advantages and disadvantages of each flowmeter type</li> <li>• Recognize accuration of each flowmeter type</li> </ul>

<b>Topic</b>		<b>Press &amp; Temp gauges, Well head, Silencer &amp; Rock Muffler and Steam Gathering System</b>
<b>Code: TECH 805</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of pressure & temperature gauges, well head, silencer, rock muffler and steam gathering system.		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Pressure and Temperature Gauges	<ul style="list-style-type: none"> <li>• Recognize the types of pressure and temperature gauges</li> </ul>
2	Operation Pressure and Temperature Gauges	<ul style="list-style-type: none"> <li>• Understand basic concept of pressure and temperature gauges</li> </ul>
3	Limitations of pressure & temperature gauges	<ul style="list-style-type: none"> <li>• Recognize advantages and disadvantages of each pressure and temperature gauges</li> </ul>
4	Components of well head	<ul style="list-style-type: none"> <li>• Describe components of well head and to know their function</li> </ul>

No	Students learn about:	Students learn to:
5	Pipe selection for gathering system	<ul style="list-style-type: none"> <li>• Understand about steam gathering system</li> <li>• Understand what factors need to be considered to select pipe for gathering system</li> </ul>
6	Thermodynamics laws in steam gathering system	<ul style="list-style-type: none"> <li>• Apply thermodynamics laws in steam gathering system</li> </ul>
7	Functions of silencer & rock muffler	<ul style="list-style-type: none"> <li>• Understand about silencer and rock muffler</li> </ul>
8	Thermodynamics laws in silencer & rock muffler	<ul style="list-style-type: none"> <li>• Apply thermodynamics laws in silencer and rock muffler</li> </ul>

Topic		Separator, Scrubber and Condensate/Steam Trap
<b>Code: TECH 806</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of separator, scrubber and condensate/steam trap.		
No	Students learn about:	Students learn to:
1	Operations of separator & scrubber	<ul style="list-style-type: none"> <li>• Recognize the types of pressure and temperature gauges</li> </ul>
2	Types of separator & scrubber	<ul style="list-style-type: none"> <li>• Understand basic concept of pressure and temperature gauges</li> </ul>
3	Components of separator & scrubber	<ul style="list-style-type: none"> <li>• Recognize advantages and disadvantages of each pressure and temperature gauges</li> <li>• Recognize accuration of each pressure and temperature gauges</li> </ul>
4	Parameters design of separator & scrubber	<ul style="list-style-type: none"> <li>• Describe components of well head and to know their function</li> </ul>
5	Thermodynamics laws in separator & scrubber	<ul style="list-style-type: none"> <li>• Understand about steam gathering system</li> <li>• Understand what factors need to be considered to select pipe for gathering system</li> </ul>
6	Thermodynamics laws in steam gathering system	<ul style="list-style-type: none"> <li>• Apply thermodynamics laws in steam gathering system</li> </ul>

No	Students learn about:	Students learn to:
7	Functions of silencer & rock muffler	<ul style="list-style-type: none"> <li>Understand about silencer and rock muffler</li> </ul>
8	Thermodynamics laws in silencer & rock muffler	<ul style="list-style-type: none"> <li>Apply thermodynamics laws in silencer and rock muffler</li> </ul>

### Syllabus Chapter C: Piping

Topic		Heat Transfer
<b>Code: TECH 807</b>		
<b>General Aim :</b>		
Students will have basic knowledge about heat transfer at geothermal well and pipeline.		
No	Students learn about:	Students learn to:
1	Heat Conduction	<ul style="list-style-type: none"> <li>Describe thermal conduction in the geothermal pipeline</li> <li>Understand the affecting factors of thermal conduction in the geothermal pipeline</li> </ul>
2	Heat Convection	<ul style="list-style-type: none"> <li>Describe thermal convection in the pipe</li> <li>Understand the affecting factors of thermal convection in the pipe</li> </ul>
3	Basic of Heat Loss	<ul style="list-style-type: none"> <li>Understand about thermal conduction and thermal convection to calculate heat loss throughout the pipeline</li> </ul>

Topic		Fluid pipes, Heat Insulator and Pipe Supports
<b>Code: TECH 808</b>		
<b>General Aim :</b>		
Students will have basic knowledge about pipeline equipment and material selection		
No	Students learn about:	Students learn to:
1	Pipe Types	<ul style="list-style-type: none"> <li>Understand the pipeline classification based on weight, material and thickness</li> </ul>
2	Pipe Failures	<ul style="list-style-type: none"> <li>Understand the types of pipe failures caused by corrosion, scaling, lifetime, etc.</li> </ul>
3	Heat Insulators for Geothermal Pipe	<ul style="list-style-type: none"> <li>Understand about the intended use of heat insulator</li> <li>Understand about the classification of heat insulator</li> </ul>
4	Basic of Insulator	<ul style="list-style-type: none"> <li>Understand about the basic knowledge of insulator</li> </ul>

	Selection	thickness selection and insulator material selection
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
5	Types of Pipe Supports	<ul style="list-style-type: none"> <li>Understand about the types of pipe support</li> </ul>
6	Basic of Pipe Support Selection	<ul style="list-style-type: none"> <li>Understand about the pipe support selection</li> </ul>

<b>Topic</b>		<b>Fittings and Valves</b>
<b>Code: TECH 809</b>		
<b>General Aim :</b>		
Students will have basic knowledge about fittings and valve design and selection		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Fittings and Valves	<ul style="list-style-type: none"> <li>Understand the fitting and valve classification based on shape and function</li> </ul>
2	Working Principles of Fitting and Valve	<ul style="list-style-type: none"> <li>Understand the working principles of fitting and valve</li> </ul>
3	Basic of Fitting and Valve Selection	<ul style="list-style-type: none"> <li>Selection the fitting and valve based on several conditions</li> </ul>
4	Safety Valves	<ul style="list-style-type: none"> <li>Understand about the intended use of safety valve</li> </ul>
5	Safety Valve Types	<ul style="list-style-type: none"> <li>Understand about the classification of safety valve</li> </ul>
6	Working Principles of Safety Valve	<ul style="list-style-type: none"> <li>Understand about working principles of safety valve</li> </ul>

#### Syllabus Chapter D: Power Plant Facilities

<b>Topic</b>		<b>Psychometrics and Cooling Tower</b>
<b>Code: TECH 810</b>		
<b>General Aim :</b>		
Students will have basic knowledge about psychometrics and working principles of cooling tower		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Psychometrics	<ul style="list-style-type: none"> <li>Understand how to use psychometrics to determine condition of air</li> </ul>
2	Cooling Tower	<ul style="list-style-type: none"> <li>Understand working principles of cooling tower</li> <li>Recognize types of cooling tower</li> <li>Recognize advantages and disadvantages of each type</li> </ul>
3	Components of Cooling	<ul style="list-style-type: none"> <li>Describe components of cooling tower and to know</li> </ul>

	Tower	their function
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
4	Operations of Cooling Tower	<ul style="list-style-type: none"> <li>Understand common failures that occurred in cooling tower operation</li> </ul>
5	Performance of Cooling Tower	<ul style="list-style-type: none"> <li>Understand how to measure efficiency of cooling tower performance</li> </ul>

<b>Topic</b>		Demister and Strainer
<b>Code: TECH 811</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of demister and strainer		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Demister and Strainer	<ul style="list-style-type: none"> <li>Understand the demister and strainer functions in geothermal power plant system.</li> </ul>
2	Working Principles of demister and strainer	<ul style="list-style-type: none"> <li>Understand the working principles of demister and strainer</li> </ul>
3	Demister Component	<ul style="list-style-type: none"> <li>Understand the demister component</li> </ul>

<b>Topic</b>		Steam turbine and Condenser
<b>Code: TECH 812</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of steam turbine and condenser		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Types and working principles of steam turbine	<ul style="list-style-type: none"> <li>Recognize the types of steam turbine and to understand the working principles of turbine</li> </ul>
2	Steam turbine component	<ul style="list-style-type: none"> <li>Know the main component of steam turbine</li> </ul>
3	Gland system	<ul style="list-style-type: none"> <li>Understand the function and working principles of gland system to increasing the effectiveness of the turbine</li> </ul>

4	Turbine governing system	<ul style="list-style-type: none"> <li>Understand the function and working principles of turbine governing system</li> </ul>
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
5	Operations and Maintenances of Steam Turbine	<ul style="list-style-type: none"> <li>Understand common failures that occurred in steam turbine operation</li> <li>Understand standard operations of maintaining steam turbine performances</li> </ul>
6	Function and Working Principles of Condenser	<ul style="list-style-type: none"> <li>Understand the function and working principles of condenser</li> </ul>
7	Types of condenser	<ul style="list-style-type: none"> <li>Know the types of condenser</li> </ul>

<b>Topic</b>	Gas Removal System (GRS)	
<b>Code: TECH 813</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of gas removal system		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Gas Removal System	<ul style="list-style-type: none"> <li>Understand working principles of GRS</li> <li>Understand function of GRS in power plant system</li> </ul>
2	Types of GRS	<ul style="list-style-type: none"> <li>Recognize the types of GRS configuration</li> <li>Recognize advantages and disadvantages of each type</li> </ul>
3	Operation of GRS	<ul style="list-style-type: none"> <li>Understand common failures that occurred in GRS operation</li> </ul>

<b>Topic</b>	Generator, Transformer and Switchyard	
<b>Code: TECH 815</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of generator, transformer and switchyard		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Generator	<ul style="list-style-type: none"> <li>Understand function and working principles of generator</li> <li>Recognize types of generator</li> <li>Recognize components of generator</li> </ul>
2	Transformer	<ul style="list-style-type: none"> <li>Understand function and working principles of transformer</li> </ul>

		<ul style="list-style-type: none"> <li>Recognize types of transformer</li> <li>Recognize components of transformer</li> </ul>
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
3	Switchyard (Power Distribution & Transmission)	<ul style="list-style-type: none"> <li>Understand function and working principles of switchyard</li> <li>Recognize components of switchyard</li> </ul>

### Syllabus Chapter E: SHE in geothermal industry

<b>Topic</b>	Main Cooling Water Pump (MCWP), Blowdown Pump and Auxiliary System	
<b>Code: TECH 814</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working principles of main cooling water pump, blowdown pump and auxiliary system		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Geothermal Fluid Pumps	<ul style="list-style-type: none"> <li>Recognize geothermal fluid pumps (MCWP and blowdown)</li> <li>Understand function of each pump</li> </ul>
2	Operation of Geothermal Fluid Pumps	<ul style="list-style-type: none"> <li>Understand common failures that occurred in each pump operation</li> </ul>
3	Auxiliary System in Power Plant	<ul style="list-style-type: none"> <li>Understand about function and working principles of cooling facilities for generator and cooling tower fan</li> <li>Understand about function and working principles of chemical facilities for silica/galena scaling inhibitor</li> </ul>

<b>Topic</b>	Safety, Health and Environment (SHE) in geothermal industry	
<b>Code: TECH 816</b>		
<b>General Aim :</b>		
Students will have basic knowledge about working safely and healthy in geothermal field		
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
1	Regulation of SHE in Indonesia	<ul style="list-style-type: none"> <li>Understand about SHE regulations in Indonesia</li> </ul>
2	Safety and Health Risks in Geothermal Industry	<ul style="list-style-type: none"> <li>Understand the job risks in geothermal industry</li> </ul>

3	Working Safety in High Places	<ul style="list-style-type: none"> <li>Understand how to minimize the risks when working in high place</li> </ul>
<b>No</b>	<b>Students learn about:</b>	<b>Students learn to:</b>
4	Working Safety in Environment with High Temperature and Poison Gas	<ul style="list-style-type: none"> <li>Understand how to minimize the risks when working in environment with high temperature and poison gas</li> </ul>
5	Working Safety in Electric Environment	<ul style="list-style-type: none"> <li>Understand how to minimize the risks when working in electric environment</li> </ul>
6	Safety equipment	<ul style="list-style-type: none"> <li>Understand types of safety equipment</li> <li>Understand about safety equipment standards</li> </ul>

#### IV. Training/Course

To implement the module that has been made, then the training organized with the following details:

Topic : Introduction of Geothermal Power Plant Operation

Time : 8-12 June 2015 and 26-30 Oct 2015

Venue : Energi Building, 2<sup>nd</sup> floor, ITB Campus

No	Waktu	Monday	Tuesday	Wednesday	Thursday	Friday
		Day 1	Day 2	Day 3	Day 4	Day 5
1	08.00 - 08.30	TECH 801	TECH 807	TECH 804	TECH 811	TECH 815
2	08.30 - 09.00					
3	09.00 - 09.30					
	09.30 - 10.00	Break	Break	Break	Break	Break
4	10.00 - 10.30	TECH 802	TECH 808 & 809	TECH 805	TECH 812	TECH 815
5	10.30 - 11.00					
6	11.00 - 11.30					
	11.30 - 12.30	Break	Break	Break	Break	Break
7	12.30 - 13.00	TECH 803	Practice 2	TECH 806	TECH 813	Break
8	13.00 - 13.30					TECH 816
9	13.30 - 14.00					
	14.30 - 15.00	Break	Break	Break	Break	Break
10	15.00 - 15.30	Practice 1	TECH 810	Practice 3	TECH 814	Closing
11	15.30 - 16.00					Discussion

The Training is occupied by a lectures who are considered to have expertise in their field, which consists of people from ITB and practitioner/professional. Here is a list of trainer member:

<b>Code</b>	<b>Trainer in June</b>	<b>Code</b>	<b>Trainer in October</b>
NM	Nenny Miryani S.	NM	Nenny Miryani S.
ABD	H. Abdurrachim	HS	Dr. Heri Sonawan
AA	M. Ali Ashat	AA	M. Ali Ashat
SAM	Sampurno S.	AN	YB. Agastyo Nugroho
AN	YB. Agastyo Nugroho	DT	Dimas Taha M.
DT	Dimas Taha M.	SAM	Ir. Sampurno S., M.Sc
		HB	Heru Berian P., ST, MT

Training were held twice in 2015 with different focusing of participants. First training on June 2015 was focused for academic member. And second training was focused for operator in geothermal industry and academic member. Total participants for 1<sup>st</sup> training is 19 trainee and 2<sup>nd</sup> training is 12 trainee