Lesson 21: Alternator Capabilities and Mechanical Power Control

ET 332b

Ac Motors, Generators and Power Systems

Learning Objectives

After this presentation you will be able to:

- Explain the power balance in and alternator.
- Identify the operating region of an alternator's capability curve.
- Explain how a governor controls mechanical power input to an alternator
- Compute governor droop.

Power Balance in Alternators

Alternator Ratings

Alternators rated in kVA or MVA at a specified power factor

Typical: 100 kVA, 480 V at 80% power factor

Active power supplied by prime mover

Reactive power determined by machine excitation

Power Balance in Alternators

Prime mover sized to handle largest active power load expected plus losses

Maximum active power load occurs When F_p =1.0 so S_{rated}= P_{out}

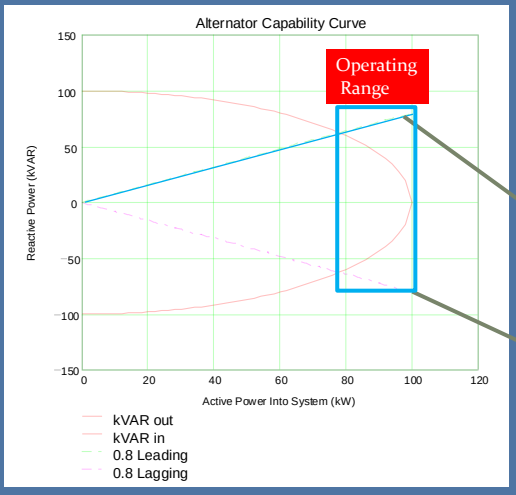
Generally

$$P_{out} = F_p \cdot S_{rated}$$

Most alternators supply reactive power also so F_p changes up to approximately 80% leading

Prime Mover :Diesel Engine

Alternator Capability Curve



Reactive power output limited by machine excitation system

In this diagram
+ kVARs are delivered
- kVARs are absorbed.

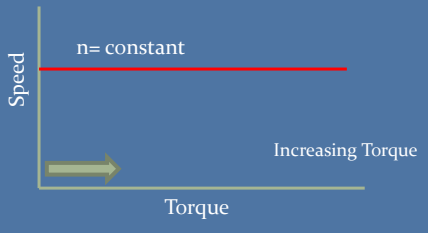
80% lead

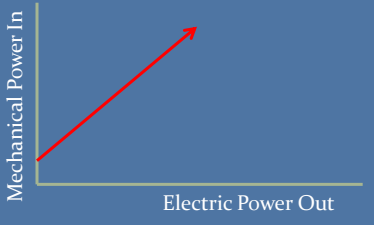
80% lag

Mechanical Power Input Control

Governor - electromechanical speed control used to maintain constant speed as machine power load changes

Power transfer between parallel alternators is controlled by change in prime-mover power input and speed. If speed remains constant, then torque increases as developed power increases





Governor Characteristic and Speed Regulation

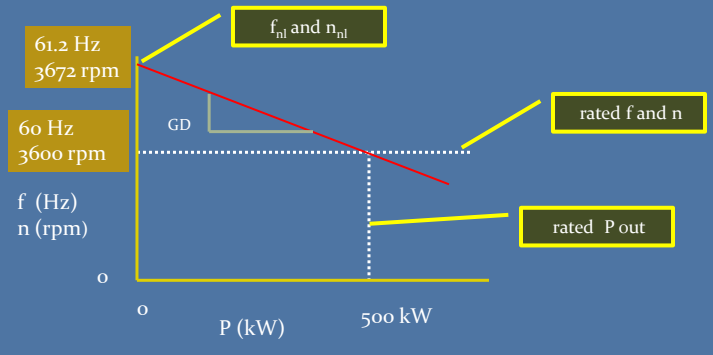
Governor Speed Regulation

$$GSR = \frac{n_{nl} - n_{rated}}{n_{rated}} = \frac{f_{nl} - f_{rated}}{f_{rated}}$$

Where n_{nl} = no-load speed of machine (rpm)
n_{rated} = rated machine speed (rpm)
f_{rated} = rated frequency (Hz)
f_{nl} = no-load frequency (Hz)

Prime-mover Governor Characteristic – relates speed (frequency) change to alternator power output

Governor Characteristic Curve

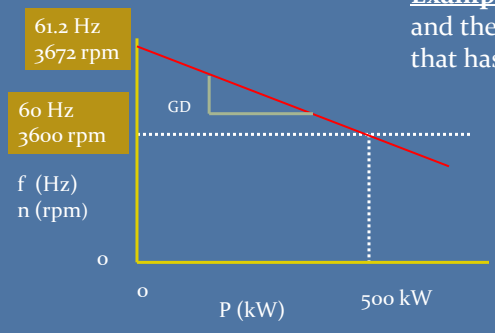


Governor Droop-the slope of the governor control characteristic.
Units - Hz\W or Hz\kW or Hz\MW

Formula $$GD = \frac{\Delta f}{\Delta P} = \frac{f_{nl} - f_{rated}}{P_{rated}}$$

Governor Characteristic Curve Example

Example 21-1: Find the speed regulation and the governor droop for the machine that has the curve shown



$$GD = \frac{\Delta f}{\Delta P} = \frac{61.2 - 60\,Hz}{500\,kW} = 0.0024\,Hz/kW$$

$$GSR = \frac{f_{nl} - f_{rated}}{f_{rated}} = \frac{61.2 - 60\,Hz}{60} = 0.02$$

End Lesson 21: Alternator Capabilities and Mechanical Power Control

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