EEL3060

Power Engineering Lab

Parallel Operation of Alternator with infinite bus

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By:

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I. Objective

To synchronize a synchronous generator with an infinite bus bar using the synchroscope and lamp methods.

II. Apparatus

- Synchronous Generator (3KVA, 415V, 6.5A, 1500rpm)
- DC Shunt Motor
- Synchronizing Panel
- Lamps for Synchronization (Dark and Bright method)
- Rheostats (Field: 2.8A, 290Ω; Armature: 15A, 50Ω)
- Ammeters (DC: 0–4.8A; AC: 0–5A)
- Wattmeter
- DC Supply (for excitation)
- AC Supply (for bus bar)

III. Theory

Synchronizing alternators to an infinite bus is essential for system stability and load sharing. Proper synchronization requires the alternator to match the bus voltage, frequency, phase angle, and phase sequence.

Synchronization Conditions

- Voltage magnitude must match.
- Frequency must match.
- Phase angle should be zero at synchronism.
- Phase sequence must be the same.

Methods Used

- **Lamp Method (Dark-Bright)**: Based on brightness variation across three lamps.
- **Synchroscope**: Shows phase difference and frequency mismatch direction.

Significance

Synchronization ensures continuous power flow, stable parallel operation, and optimal load sharing in power systems.

IV. Experimental Procedure

1. Connect the circuit as per diagram.
2. Start the DC shunt motor and attain rated speed using rheostat.
3. Excite the synchronous generator rotor with DC.
4. Switch ON the AC supply to the bus bar.
5. Match generator voltage to bus voltage using field rheostat.
6. Match frequency by adjusting DC motor speed.
7. Synchronize using lamp method or synchroscope.
8. After synchronization, gradually increase generator field current.
9. Record armature current, power, and calculate power factor.

V. Observation Tables

1. Change in Excitation

Field Current (A)	Armature Current (A)	P (kW)	Q (kVAR)	S (kVA)	PF
1.32	1.0	0.24	-0.14	0.84	0.29 (ld)
1.38	1.2	0.28	0.10	0.90	0.31 (lg)
1.46	1.5	0.32	0.35	1.02	0.31 (lg)
1.52	1.76	0.35	0.54	1.13	0.31 (lg)
1.26	1.0	0.45	-0.33	0.93	0.48 (ld)
1.16	1.2	0.49	-0.71	1.09	0.45 (ld)
1.10	1.4	0.49	-0.99	1.27	0.39 (ld)
0.98	1.8	0.50	-1.42	1.60	0.31 (ld)

2. Change in Speed

Field Current (A)	Armature Current (A)	P (kW)	Q (kVAR)	S (kVA)	PF
1.4	1.35	0.56	0.05	1.01	0.55 (lg)
1.4	1.40	0.73	-0.02	1.13	0.65 (ld)
1.4	1.44	0.79	-0.07	1.15	0.69 (ld)
1.4	1.68	1.01	-0.10	1.30	0.78 (ld)
1.4	1.80	1.10	-0.19	1.37	0.80 (ld)
1.4	1.20	0.37	0.05	0.89	0.42 (lg)
1.4	1.20	0.21	0.10	0.86	0.24 (lg)
1.4	1.20	0.14	0.12	0.84	0.17 (lg)
1.4	1.20	0.10	0.13	0.85	0.12 (lg)

Note: lg = lagging, ld = leading

VI. Result and Discussion

Effect of Changing Excitation (at Constant Speed)

As the field current increased from 0.98 A to 1.52 A, armature current and apparent power also increased. At lower excitation, reactive power was negative (leading PF), shifting to positive (lagging PF) as excitation rose. This shows excitation controls reactive power flow and thus adjusts power factor, without major impact on real power.

Effect of Changing Speed (at Constant Excitation)

At a constant field current of 1.4 A, increasing speed increased armature current and real power output from 0.10 kW to 1.10 kW. Reactive power showed minor variation, and power factor improved significantly from 0.12 to 0.80, indicating more efficient operation.