Tools for Comparing Engine Performance

Orientation:

In this activity you will explore SI and CI engines that range in size from 50 cc to over 25000 liters. The mean piston speed (S_p) and brake mean effective pressure (bmep) will be introduced as tools for scaling engine performance. In this course, knowing typical mean piston speed and bmep will allow you to make predictions/assumptions necessary to solve many problems.

Learning Objectives:

- 1. Calculate mean piston speed as well as bmep from engine manufacturer specifications.
- 2. Identify typical values for mean piston speed and bmep for SI and CI engines.
- 3. Propose reasons for differences in mean piston speed and bmep within SI and CI engines because of special design considerations.

Targeted Skills:

Identifying assumptions – examining preconceptions/biases Generalizing solutions – modifying for broader applicability Persuading – using information selectively to convince

| isuu | ding using information selectively to convince |
|------|---|
| 1) | Write an expression for total engine displacement based on cylinder geometry. |
| 2) | Write an expression for mean piston speed in m/s based on cylinder geometry and speed at maximum power. |
| 3) | Write an expression for bmep in terms of max power, displacement, engine type, and speed. |

SI Engines

| Model | Application | Neyl | Type | Bore | Stroke | Max | Speed@ |
|--------------|---------------|------|----------|---------|---------|--------|-----------|
| | | | | | | Power | Max Power |
| Suzuki | moped | 1 | 2-stroke | 39.7 mm | 39.7 mm | 5 kw | 7000 rpm |
| Polaris | snowmobile | 2 | 2-stroke | 77 mm | 64 mm | 138 hp | 8500 rpm |
| Ford Focus | passenger car | 4 | 4-stroke | 3.44 in | 3.27 in | 140 hp | 6000 rpm |
| Lamborghini | sports car | 10 | 4-stroke | 82.5 mm | 92.8 mm | 388 kw | 8000 rpm |
| Cadillac CTS | sports sedan | 8 | 4-stroke | 4.06 in | 3.62 in | 556 hp | 6100 rpm |

CI Engines

| Model | Application | Ncyl | Type | Bore | Stroke | Max Power | Speed@ Max Power |
|-------------|---------------|------|----------|---------|---------|--------------|---------------------|
| Cummins | genset | 2 | 2-stroke | 65 mm | 65 mm | 25 kw | 3600 rpm |
| Audi R10 | racecar | 12 | 4-stroke | 80 mm | 91.4 mm | 650 hp | 5000 rpm |
| Dodge | pick-up truck | 8 | 4-stroke | 99.5 mm | 90 mm | 350 hp | 3000 rpm |
| Caterpillar | semi truck | 6 | 4-stroke | 5.4 in | 6.75 in | 625 hp | 2100 rpm |
| Sulzer | container | 14 | 2-stroke | 38 in | 98 in | 100000 hp | 100 rpm |
| | ship | | | | | | |

4) Calculate the total engine displacement (in cubic meters as well as liters), mean piston speed (in m/s), and bmep (in kPa) for each of the engines you are assigned.

Handy Dandy Conversions

1 in = .0254 m

1 ft-lb = 1.35 N-m

1 hp=.746 kw 1 $m^3 = 1000$ liters

| Model | Displacement (meters ³) | Displacement (liters) | Mean Piston Speed (meters/sec) | Brake Mean Effective Pressure (kpa) |
|-------|-------------------------------------|-----------------------|--------------------------------------|---|
| | | | | |
| | | | | |
| | | | | |

| 5) | What general trends do you observe in mean piston speed between SI and CI engines? Why? |
|-----|---|
| 6) | What general trends do you observe in bmep between SI and CI engines? Why? |
| 7) | Is there any relationship between total displacement and mean piston speed or bmep? Why? |
| 8) | What trends do you observe in mean piston speed and bmep within the SI engines? Speculate on reasons for this. |
| 9) | What trends do you observe in mean piston speed and bmep within the CI engines? Speculate on reasons for this. |
| 10) | How would you estimate the max speed and maximum power of an engine if you only knew its type and displacement? |
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