Dual-fuel retrofit emissions

Is a simple measurement procedure possible?

Dual-fuel retrofit emissions

- Emission limits of HD engines are specified as brake specific emissions

- Easy to measure on an engine test bench
- Difficult to determine for a retrofitted engine mounted in a vehicle
- Possible solutions:
  - CO_2 specific emissions
  - O_2 used

CO_2 specific emissions

- Advantage:

  Good correlation with brake specific emissions

  Only small influence of efficiency variations and differences between indicated and effective work

  Less measurement errors due to leakage etc.

- Possible problem: Influence of H/C ratio variations

H/C ratio, CO_2 and O_2

- Preliminary assessment based on calculations

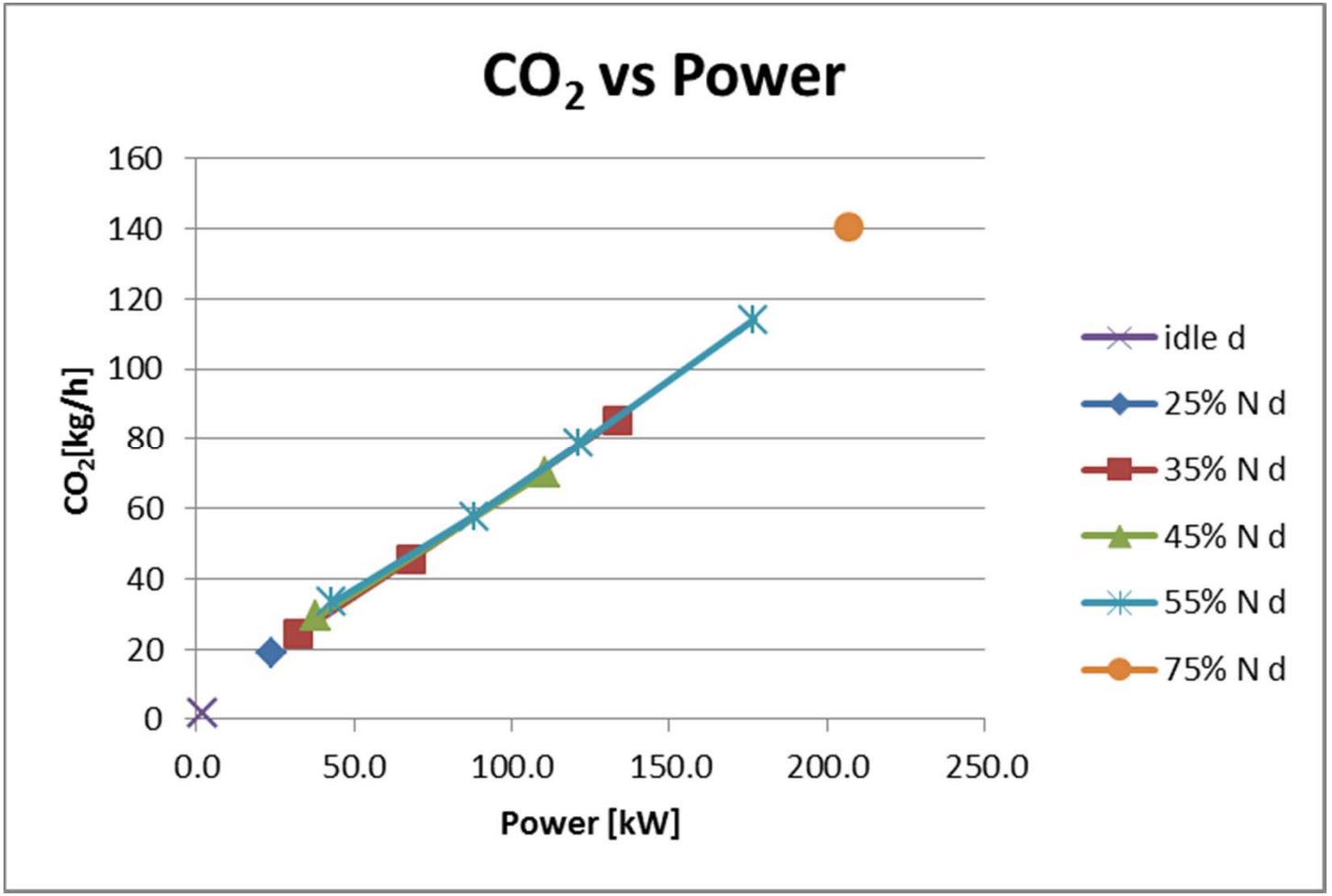
  (equal power output independent of Gas Energy Ratio)

- Result:

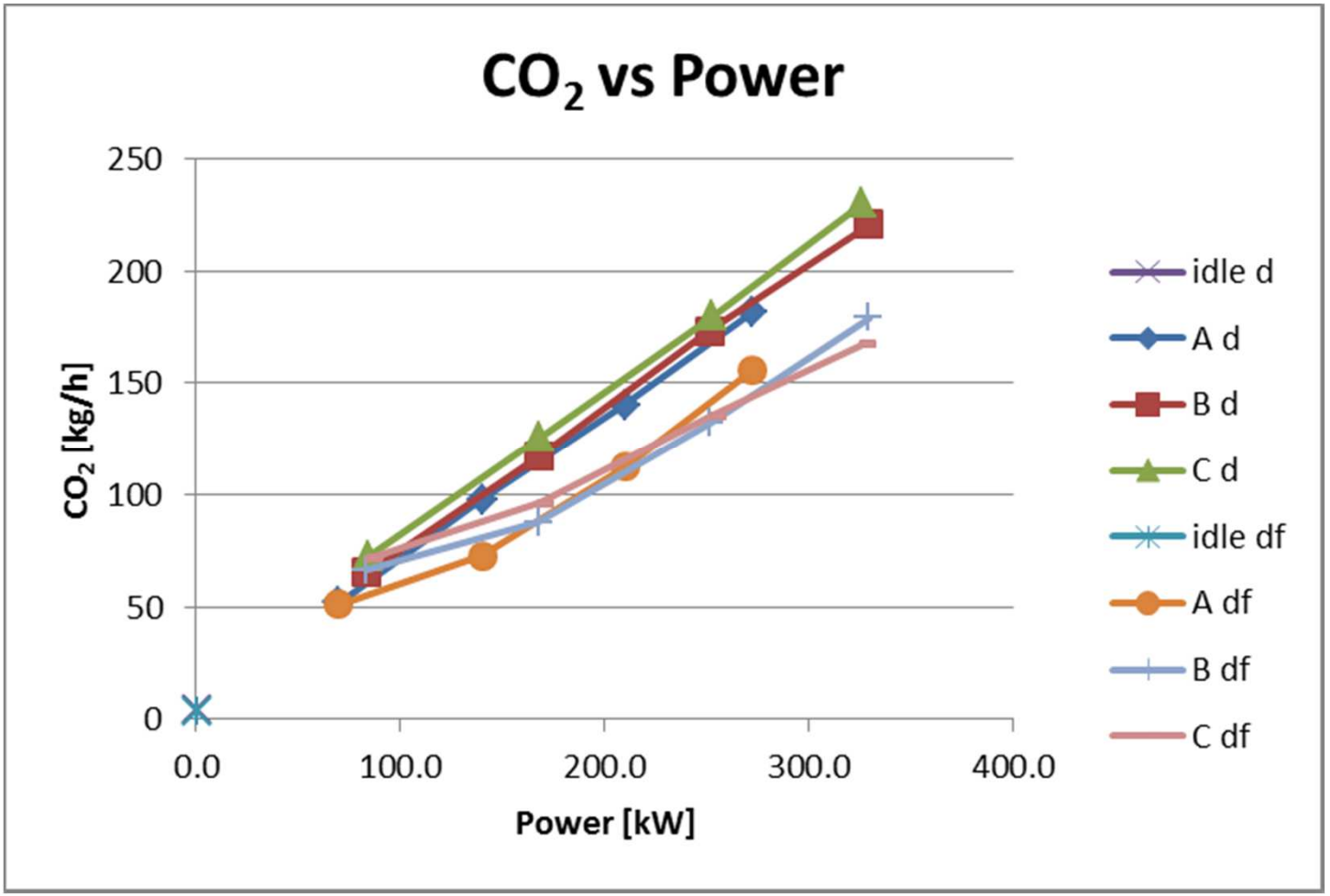
  variation from 100% diesel -> 100% gas:

  - LPG Influence on CO_2 <10% on O_2 < 2%
  - CH_4 Influence on CO_2 <25% on O_2 < 3%

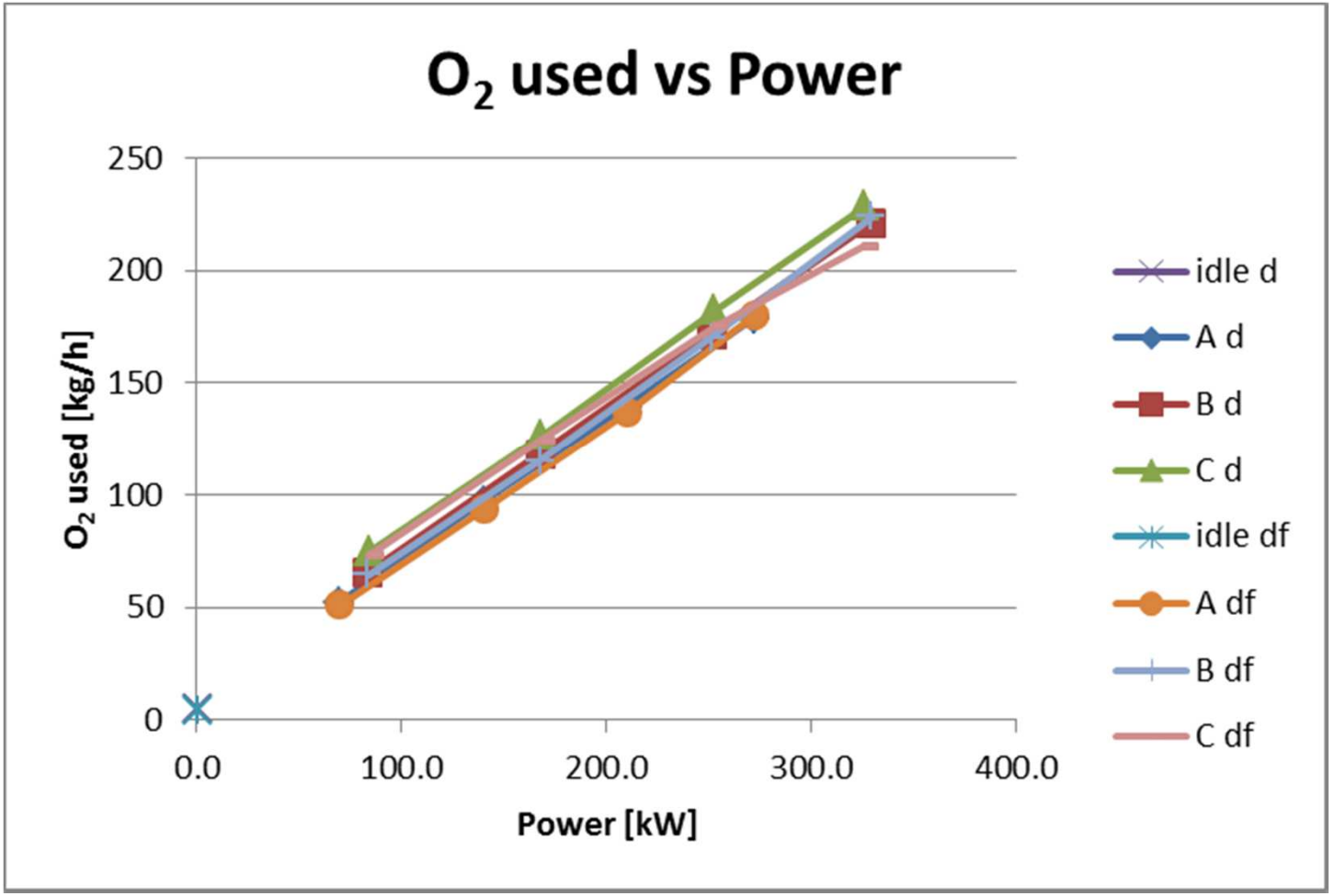
Diesel engine - PEMS equipment



Dual-fuel engine - Lab equipment



Dual-fuel engine - Lab equipment



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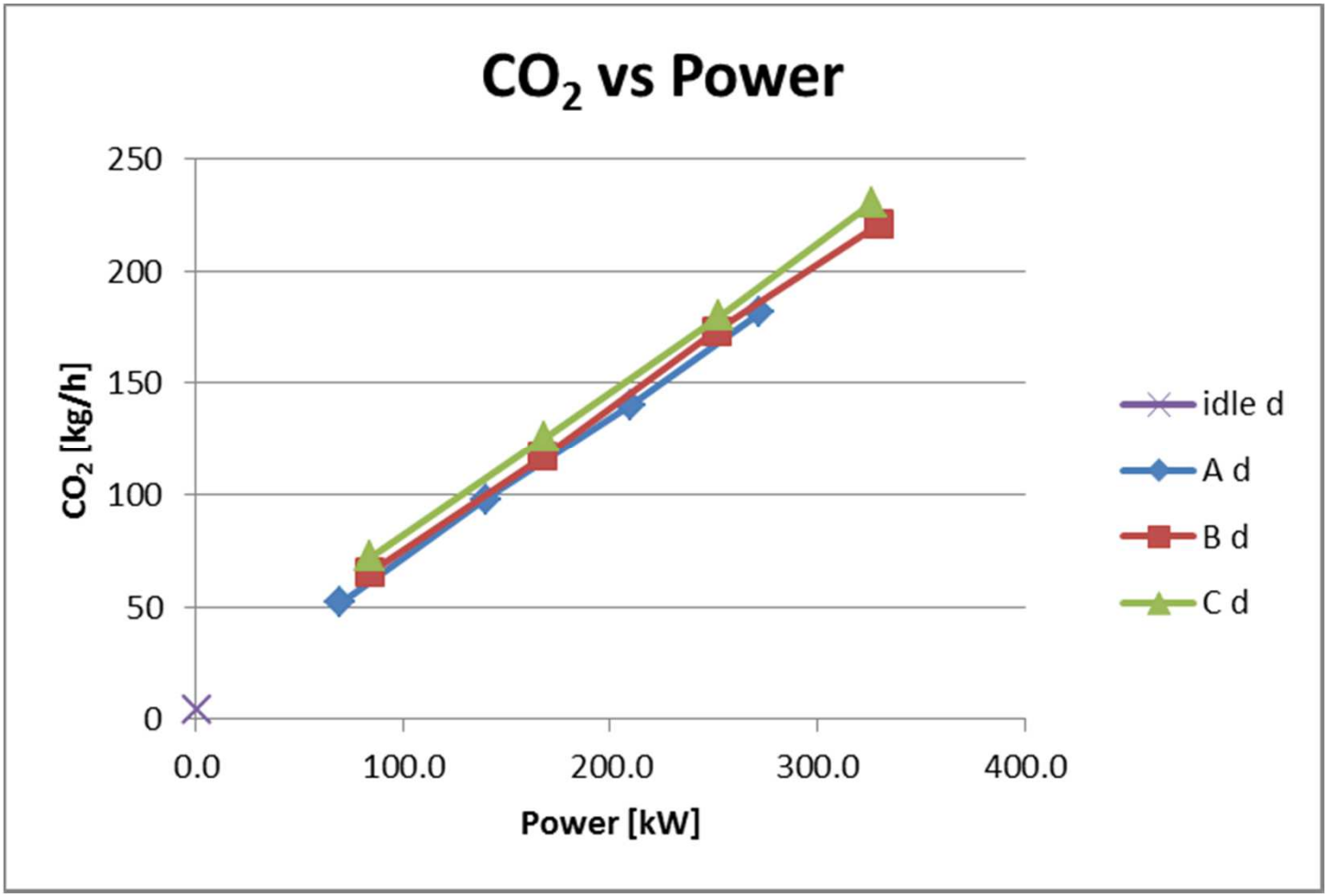
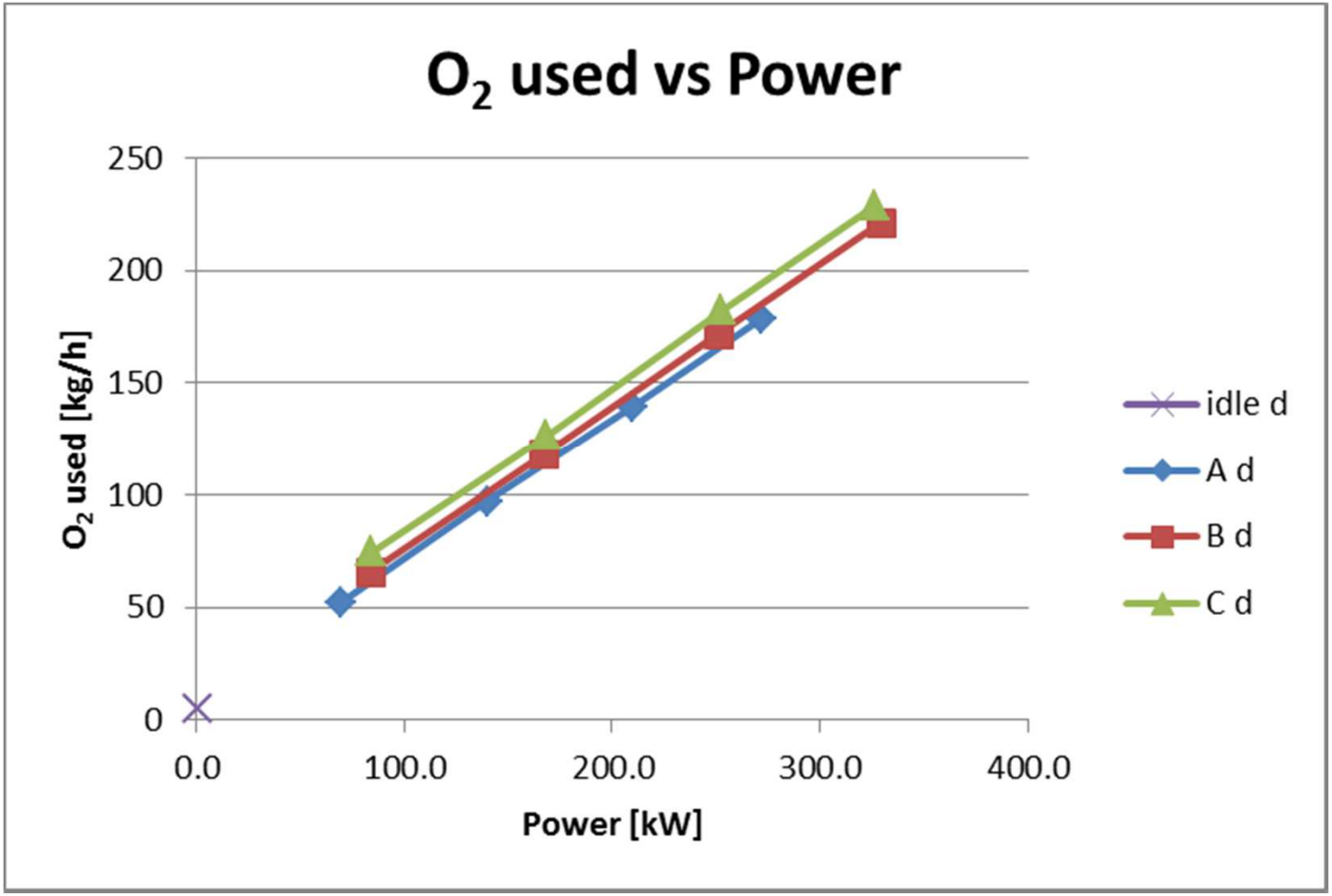
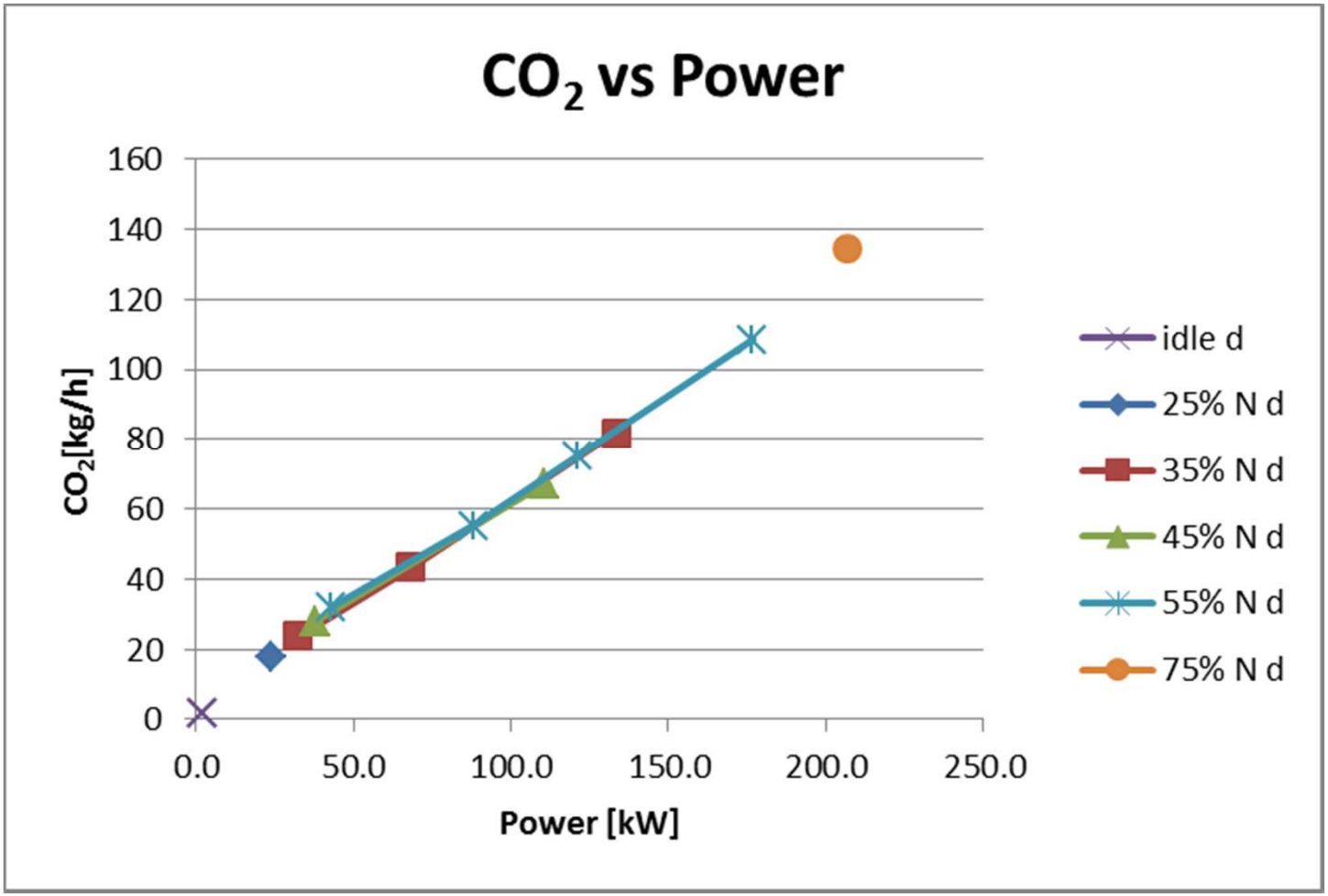


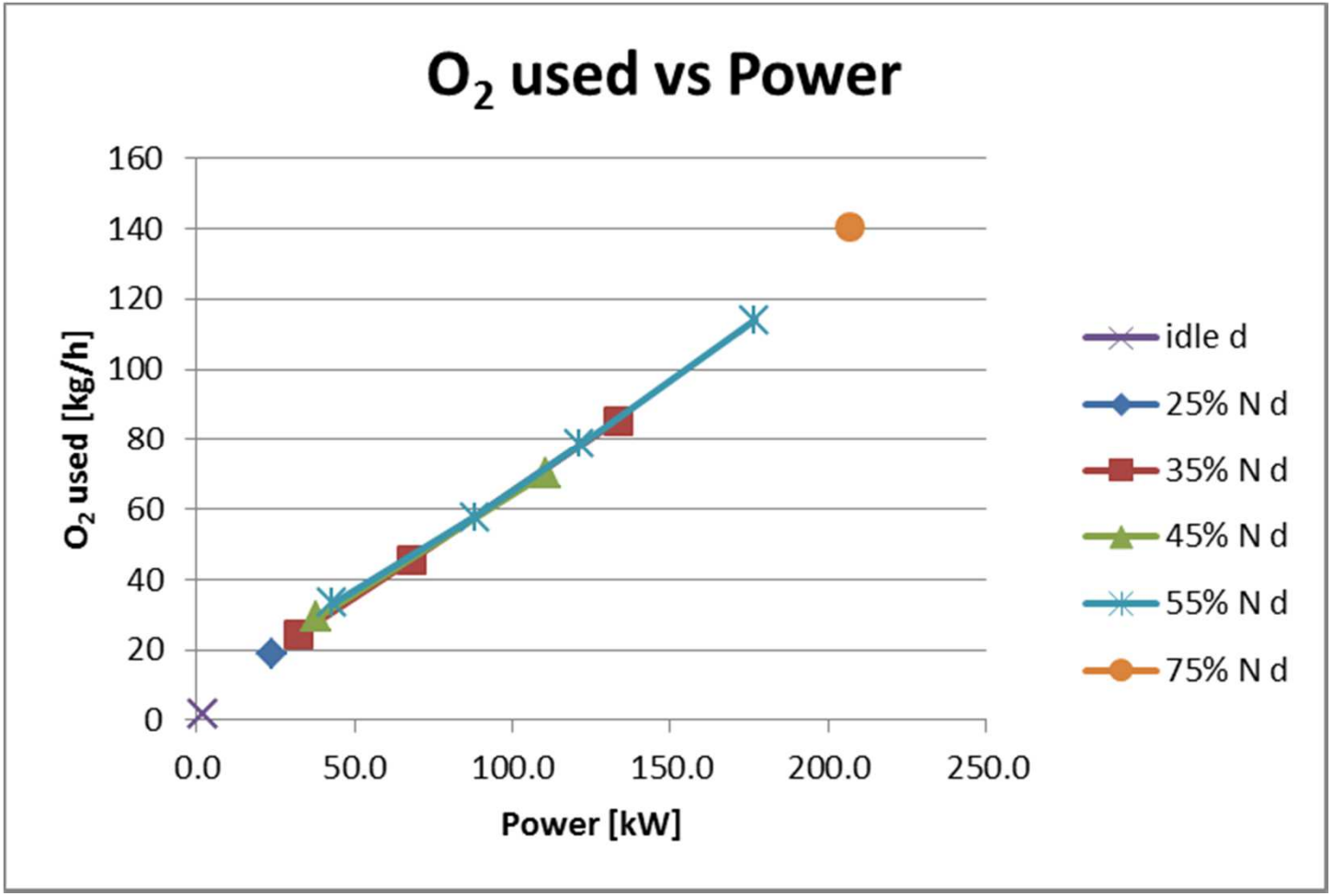
Dual-fuel engine - Lab equipment



Diesel engine - PEMS equipment



Diesel engine - PEMS equipment



Preliminary conclusions

- Calculation of CO_2 specific emissions for dual-fuel operation has disadvantages.
- The amount of Oxygen needed to release a certain amount of energy from an air/fuel mixture appears reasonably insensitive to the fuels used for a dual-fuel engine.
- Work specific emissions calculation based on “used Oxygen” determination seems sufficiently accurate for HDDF retrofit emission measurements.

- More validation work remains necessary.
- PEMS equipment does not always measure O_2 emissions.

Chosen approach (1)

- Back-to-back measurement:
  The pollutant emissions during dual-fuel operation shall be lower than or equal to those during diesel operation.
- Derogation possible for CO: lower than emission limit.
- No CH_4 requirement *(no diesel value for CH_4)*.
- Still discussion regarding possible NMHC derogation.

Chosen approach (2)

Back-to-back measurement

Choice from:

- Test bench measurement
- Chassis dyno
- On road test using PEMS

Chosen approach (2)

Back-to-back approach

Choice from:

- Test bench measurement

  brake specific emissions
- Chassis dyno

  total emissions, [g/s] or [g/kWh] at the wheels
- On road test using PEMS

  average emissions in [g/s]