# Power Sources for Irrigation Pumping

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# Power Plants Available

- Spark Ignition Engines
  - Vapor fueled w/ LP or Natural Gas
- Electric Motors
  - AC, 3 Phase, Vertical, Hollow Shaft
  - AC, 1 Phase, Submersible or Centrifugal
  - DC, For Photovoltaic Systems
- Diesel Engines
  - Diesel Fuel
  - Possible dual fueled

# Spark Ignition Engines

- Advantages
  - Burns natural gas, the cheapest fuel
  - Relatively easy to service
  - Variable pump flow rate
- Disadvantages
  - Wears with time
  - Can be noisy
  - Requires considerable service

# Large Electric Units

- **Advantages**
  - Easy to operate
  - Very low maintenance
  - Very long life
  - Can be dual-fueled with IC engines
- **Disadvantages**
  - Requires 3-phase power lines
  - May be expensive to install
  - Single speed of operation
  - Can be damaged by Lightning

# Diesel Engines

- Advantages
  - More efficient than spark ignition engines
  - May have longer life
  - May be able to use dual-fuel
- Disadvantages
  - Heavier and more expensive than SI engines
  - Fire hazard from stored fuel on site

# Cost of fuels

- **Natural Gas (MCF)**
  - **1045 BTU/FT3 X 1,000 X (12.6/14.7) X 0.20 = 179,000 BTU**
  - **Cost = $7.50**
- **LP Gas (Gal)**
  - **97,000 BTU/Gal X 0.20 = 19,000 BTU/ Gal**
  - **179,000 / 19,000 = 9.4 Gal**
  - **Cost = 9.4 Gal X $2.50 = $23.17**
- **Diesel (Gal)**
  - **137,000 BTU/Gal X 0.30 = 41,000 BTU/Gal**
  - **179,000 / 41,000 = 4.53 Gals**
  - **Cost = 4.53 Gal  X $4.00 = $17.40**

# Cost of fuels (cont)

- Electric (KWH)
  - 1 KWH = 3,415 BTU X 0.90 = 3,074 BTU/KWH
  - 179,000 / 3,074 = 58.2 KWH
- Small System (< 7.5 HP, Summer)
  - Cost = 58.2 X $0.12 = $7.00
- Large System ( Summer,  24 Hr., 7 Day Average)
  - Cost = 58.2 X 0.13 = $7.57
- All Systems Plus $240/ Year

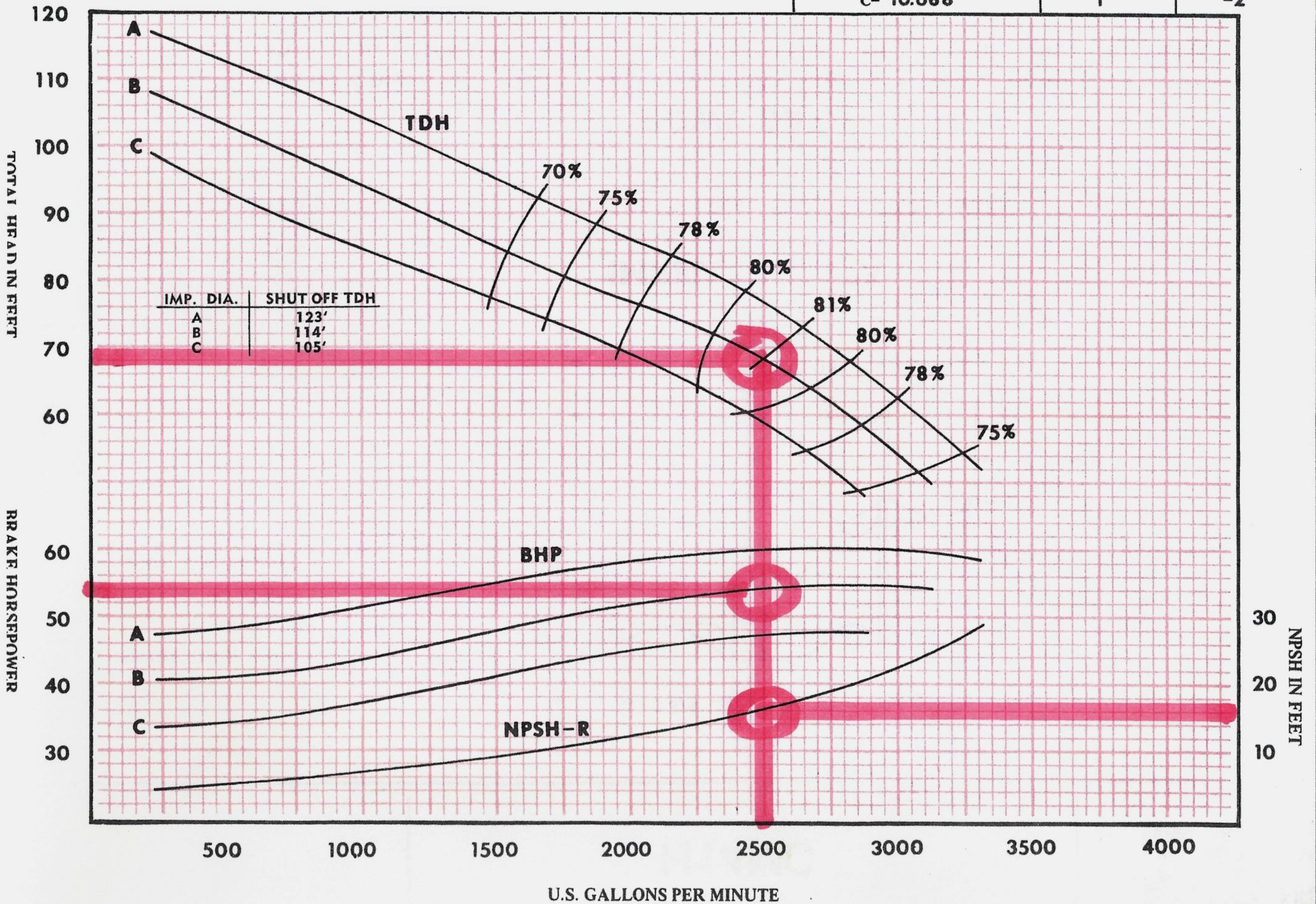
# Sizing Power Units

- Determine pump speed and power required
  - Normal pump speed is 1750 or 3500
  - Power from pump curves
  - For IC Engines, determine gear head ratio
- All power units must be larger than required
  - For Electric motors, the next size up
  - For IC engines, 15 to 20 percent higher

# H14MC

ONE STAGE PERFORMANCE
1770 R.P.M.

| IMPELLER DIAMETER | EFFICIENCY | CHANGE |
|---|---|---|
| | NO. OF STAGES | NO. OF POINTS |
| A= 11.688 | 3 | 0 |
| B= 11.188 | 2 | -1 |
| C= 10.688 | 1 | -2 |



# Horsepower Calculation

- Pump Requirement …………………..……54.0 Hp
  - Shaft Friction……………………………1.1 Hp
  - Thrust bearing…………………………..3.0 Hp
- Total for Electric Drive………………..…58.1 Hp
  - Gear Head Loss (1.0 %)……..………. 0.6 Hp
- Total for IC Engines…………………..…58.7 Hp
  - Oversize for wear (16 %)……………. 8.8 Hp
- Total Rating for IC Engines…............67.5 Hp
- Altitude Adjustment (14.7/12.6)…….78.8  Hp

# IC Engine Options

- Industrial Engines
  - Self contained, fuel and power connections only
  - Expensive
- Automotive engines adapted for pumping
  - No wasted power on radiator fan
  - Requires a cooling coil in pumped water stream
  - Safeties on oil pressure and water temp only
  - Relatively inexpensive

# GM POWERTRAIN

## Industrial Engines

VORTEC ENGINES

GM Powertrain takes its expertise in designing outstanding Vortec truck and SUV engines and leverages it to make sophisticated yet extremely durable industrial engines.

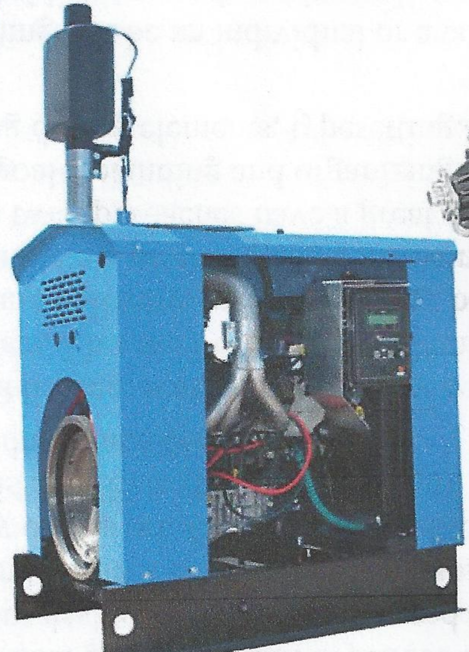
# Vortec™ 4.3L

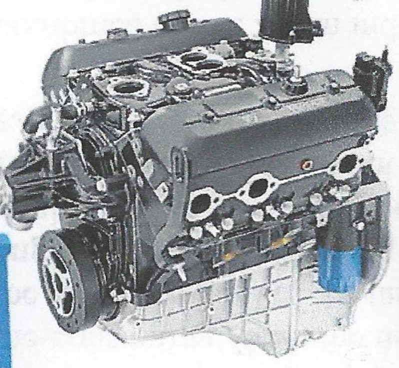
## 6 Cylinder – 262 Cubic Inches

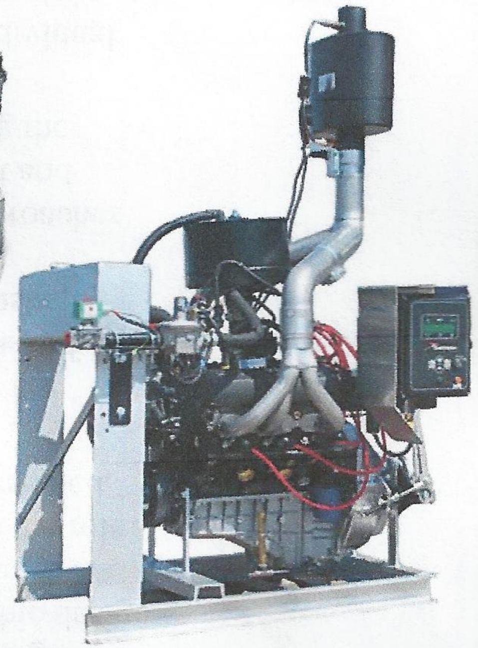
### Applications

**Industrial, Agriculture Construction & Oilfield**

- **Pumps –** Irrigation, Industrial, Hydraulic Sludge and Trash
- **Compressors –** Natural Gas and Air
- **Generators –** Prime Power, Standby and Co-Gen
- **Industrial Drives –** Forklifts, Manlifts, Street Sweepers, Wood Chippers, Chillers and Fans
- **Oil and Gas Production –** Gas Compressors, Pump Jacks, Vapor Recovery
- **Wind Machines**
- **Numerous Re-Power & Custom Applications**







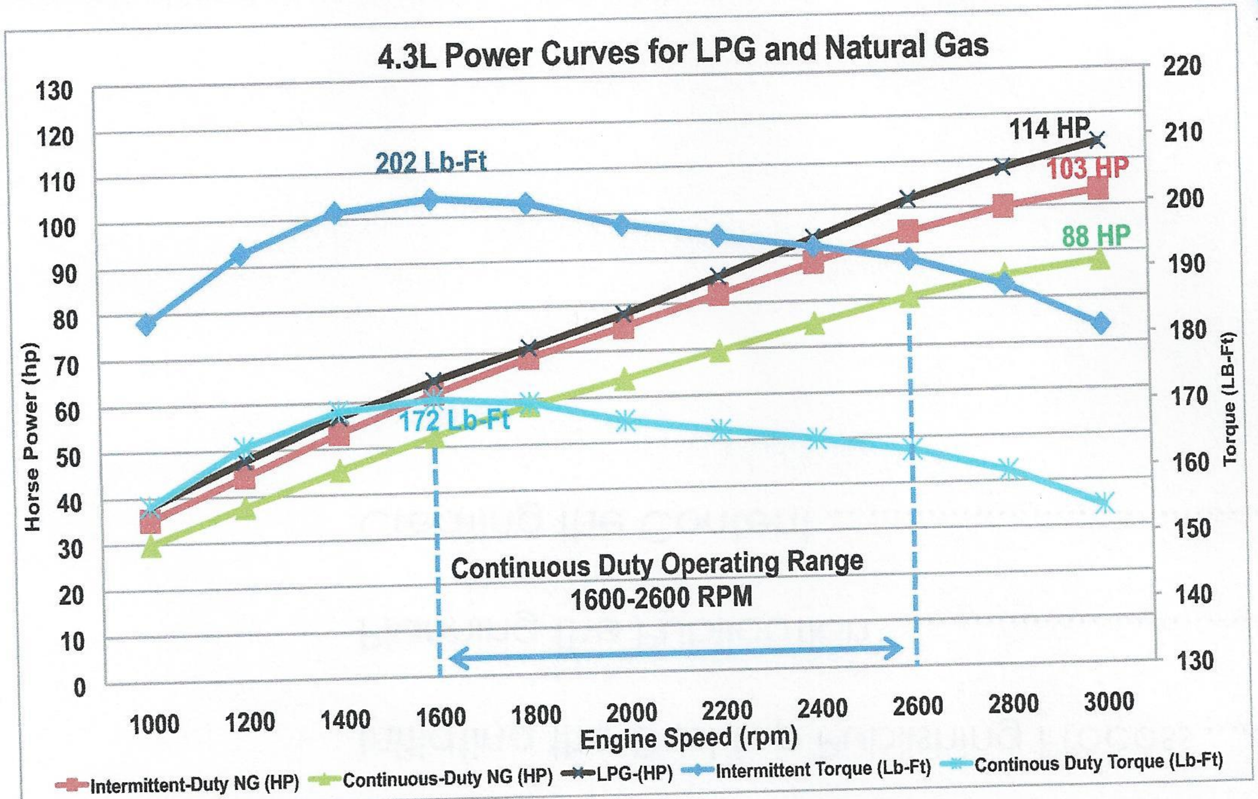
### Available Factory

GM

# POWERTRAIN Industrial Engines

VORTEC ENGINES

## Vortec™ 4.3L 6 Cylinder – 262 Cubic Inches




Power and torque values provided by Buck's Engines per SAE1349. Actual power levels may vary depending on fuel selection and quality, calibration, application, altitude and ambient air temperatures.

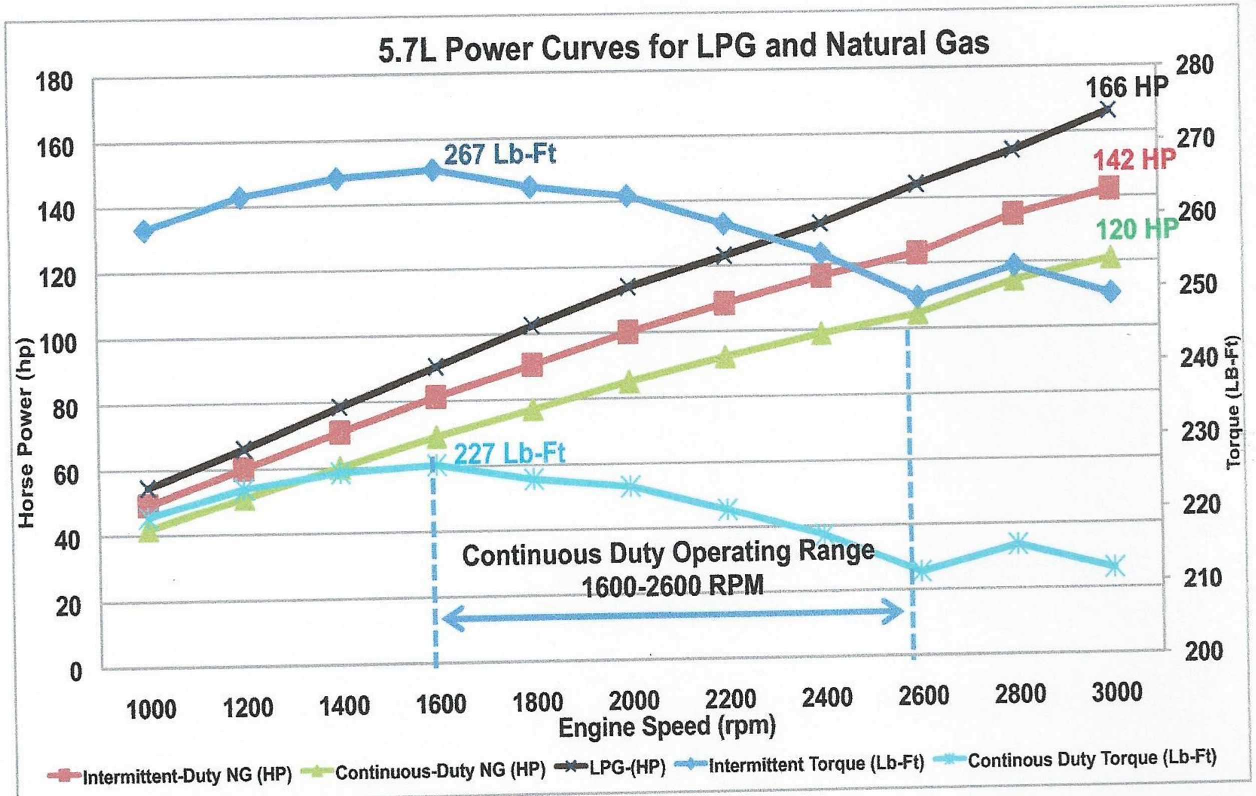
### Specifications and Materials

- **Type:** 90° 4.3L V6
- **Displacement:** 262 cld (4294 cc)
- **Compression Ratio:** 9.4:1
- **Valve Configuration:** Overhead /Pushrod Actuated
- **Valve Lifters:** Hydraulic Roller
- **Bore x Stroke:** 4.00 x 3.48 in (101.60 x 88.39 mm)
- **Main Bearing Caps:** 2-Bolt
- **Balance Method:** External
- **Intake Manifold:** Two-barrel
- **Firing Order:** 1-6-5-4-3-2

# GM POWERTRAIN Industrial Engines

VORTEC ENGINES

## Vortec™ 5.7L 8 Cylinder – 350 Cubic Inches




Power and torque values provided by Buck's Engines per SAE1349. Actual power levels may vary depending on fuel selection and quality, calibration, application, altitude and ambient air temperatures.

### Specifications and Materials

- **Type:** 90° 5.7L V8
- **Displacement:** 350 cid (5736 cc)
- **Compression Ratio:** 9.4:1
- **Valve Configuration:** Overhead /Pushrod Actuated
- **Valve Lifters:** Hydraulic Roller
- **Bore x Stroke:** 4.00 x 3.48 in (101.60 x 88.39 mm)
- **Main Bearing Caps:** 2-Bolt
- **Balance Method:** External
- **Intake Manifold:** Four-barrel
- **Firing Order:**

# Gear Head Selection

- 4.3 Liter Engine
  – 2,400 RPM…………4:3 Gear head
  – List Price = $6,975
- 5.7 Liter Engine
  – 1,700 RPM…………1:1 Gear head
  – List Price = $7,675

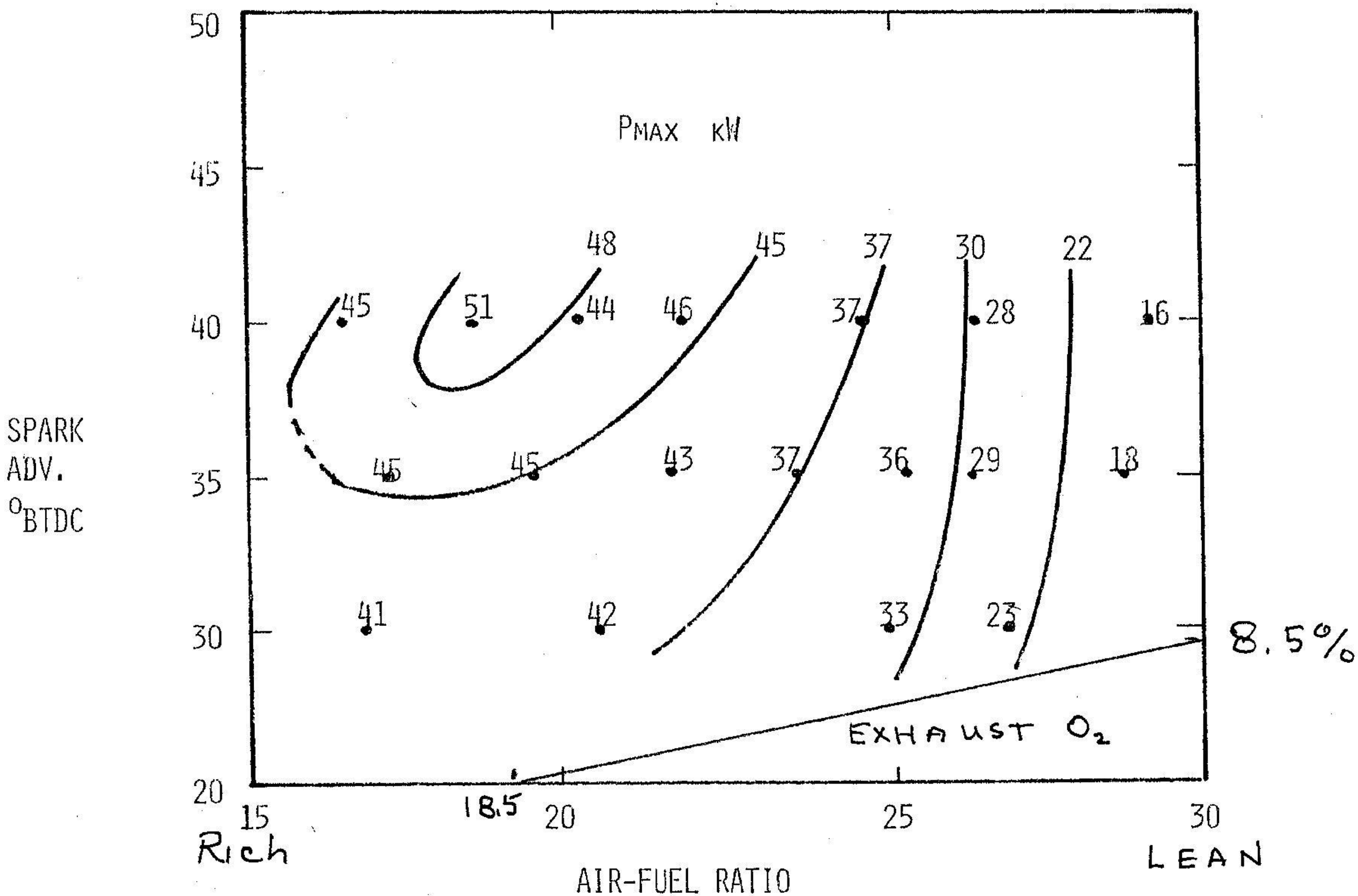



Figure 4. Effect of air-fuel ratio and spark timing on the maximum power of a 4.8L engine with 8:1 compression ratio fueled with natural gas.

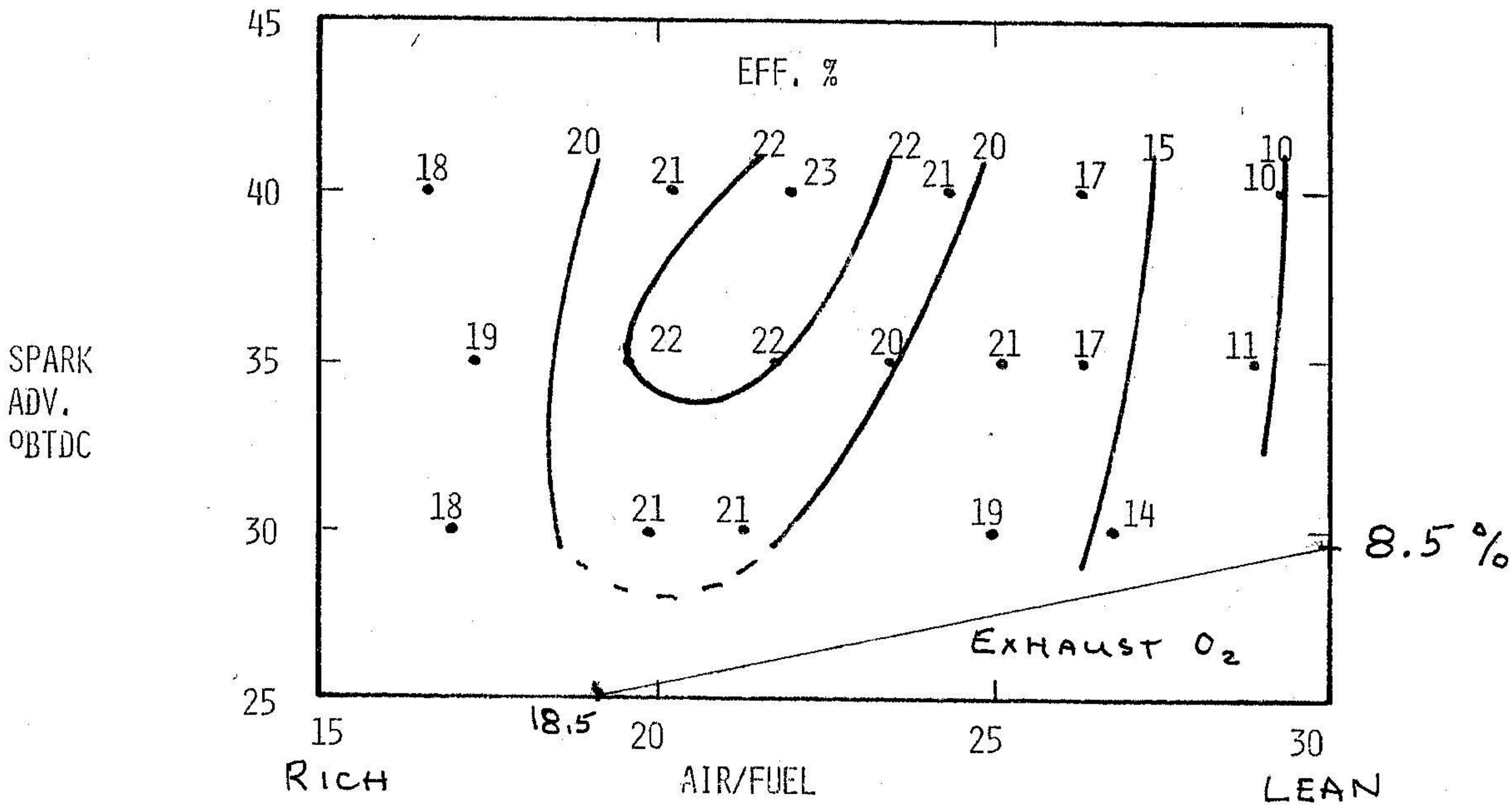



Figure 5. Effect of air-fuel ratio and spark timing on the efficiency of a 4.8L spark ignition engine with 8:1 compression ratio fueled with natural gas.

TABLE 1. MAXIMIZING THE EFFICIENCY OF VAPOR FUELED ENGINES

| ENGINE | COMP. RATIO | SPARK TIMING | | | |
|---|---|---|---|---|---|
| | | $30^{\circ}$ BTDC | | $40^{\circ}$ BTDC | |
| | | MAX POWER KW/L | EFF. % | MAX POWER KW/L | EFF. % |
| 4.8L | 8:1 | 8.71 | 20.8 | 8.82 | 21.5 |
| 4.1L | 9:1 | 10.60 | 23.4 | 10.12 | 21.9 |

RUNS SELECTED WITH AIR-FUEL RATIOS GREATER THAN 18:1 BUT LESS THAN 22:1.

# Conclusions

- **Natural gas is most economical fuel**
  - **If available, electrical power is also economical**
- **New IC engines must be matched to the load**
  - **80 - 85 percent of capacity**
  - **SI engines should be tuned for maximum efficiency**
    - **Low air-fuel ratio**
    - **Early spark timing**
    - **Keep engine in reasonable condition**
- **Be prepared for higher fuel prices**
  - **World competition for HC fuels**
  - **Natural Gas supply appears stable**
  - **Atmospheric CO2 remediation will be necessary**