# Reciprocating Compressor Performance — Report

Calculation summary | PlantCalcKit v1.0

## DOCUMENT

| | |
|---|---|
| Plant / project | **Example Plant** |
| Equipment tag / system | **K-101** |
| Calculation / document no. | **CALC-RC-001** |
| Revision | **0** |
| Prepared by | **Your name** |
| Checked by | **—** |
| Date | **07-Nov-2026** |
| **Calculation basis** | Gas: Mixture — Natural gas (typical pipeline) · 2 stages · Volumetric basis: Real-gas isentropic (Peng–Robinson) · Compare with plant readings · Flow: Actual inlet volume flow · Power: Brake power at the coupling · Peng–Robinson real-gas states with ideal-gas cp polynomials; clearance-volume, power and rod-load relations aligned with the publicly documented GPSA / Brown / API 618 methods |
| Status | **✓ Inputs OK · ℹ️ 15 default value(s) in use: added clearance when the pocket is open, suction valve + pulsation pressure loss, discharge valve + pulsation pressure loss, leakage / slippage allowance, intercooler approach limit, interstage pressure-loss limit, maximum discharge temperature, atmospheric pressure, indicated, mechanical efficiency of the frame, driver and drive-train efficiency, operating time, energy price,** |

## KEY INPUTS

| Input | Unit | Value used |
|---|---|---|
| Compressor speed | rpm | 400 |
| Measured flow into stage 1 (actual inlet volume) | m³/h | 1,250.0 |
| Measured power | kW | 600.0 |
| Cooling-medium inlet temperature (intercoolers) | °C | 28.0 |
| Intercooler approach limit | K | 15.0 |
| Interstage pressure-loss limit | % | 5.0 |
| Maximum discharge temperature | °C | 150.0 |
| Atmospheric pressure (rod-load reference) | bar a | 1.01325 |
| Indicated (adiabatic) efficiency | % | 95.0 |
| Mechanical efficiency of the frame | % | 95.0 |
| Driver and drive-train efficiency | % | 95.0 |
| Operating time | h/yr | 8,000 |
| Energy price (USD per unit shown) | per MWh | 80.00 |

## STAGE DATA — VALUES USED

| Input | Unit | Stage 1 | Stage 2 | | |
|---|---|---|---|---|---|
| Cylinders in parallel in the stage | | 1 | 1 | | |
| Cylinder action | | Double acting | Double acting | | |
| Cylinder bore | mm | 400.0 | 245.0 | | |
| Stroke | mm | 300.0 | 300.0 | | |
| Piston rod diameter | mm | 90.0 | 80.0 | | |
| Clearance volume (average of both ends) | % | 14.0 | 14.0 | | |
| Capacity control in use | | Full load | Full load | | |
| Added clearance when the pocket is open | % | 10.0 | 10.0 | | |
| Suction pressure at the stage inlet flange (line) | bar a | 6.000 | 16.400 | | |
| Discharge pressure at the stage outlet flange (line) | bar a | 17.000 | 45.000 | | |
| Suction temperature at the stage inlet | °C | 35.0 | 38.0 | | |
| Suction valve + pulsation pressure loss (% of line pressure) | % | 3.0 | 3.0 | | |
| Discharge valve + pulsation pressure loss (% of line pressure | % | 3.0 | 3.0 | | |
| Leakage / slippage allowance (% of swept volume) | % | 3.0 | 3.0 | | |
| Measured discharge temperature (line) | °C | 124.0 | 140.0 | | |
| Rod gas-load rating — compression | kN | 220.0 | 175.0 | | |
| Rod gas-load rating — tension | kN | 160.0 | 150.0 | | |
| Discharge pressure for the rod-load check (line) | bar a | | 49.000 | | |

## RESULTS — MACHINE SUMMARY

| Result | Unit | Value |
|---|---|---|
| Gas state at stage-1 suction | — | no condensation expected |
| Gas molar mass | g/mol | 17.589 |
| Machine throughput, standard volume (stage-1 capacity) | Sm³/h | 7,433.4 |
| Machine throughput, mass flow | kg/h | 5,545.4 |
| Overall compression ratio (last discharge / first suction, line) | — | 7.500 |
| Total indicated power | kW | 567.2 |
| Total brake power (expected) | kW | 597.1 |
| Electrical power drawn (expected) | kW | 628.5 |
| Specific brake power (expected) | kWh/1000 Sm³ | 80.327 |
| Annual energy cost at the expected power | USD/yr | 402,258 |

## RESULTS — STAGE PRESSURES AND GAS STATE

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Suction pressure at the cylinder (after valve and pulsation los | bar a | 5.820 | 15.908 | | | |
| Discharge pressure at the cylinder (incl. valve and pulsation l | bar a | 17.510 | 46.350 | | | |
| Compression ratio, line (discharge / suction) | — | 2.833 | 2.744 | | | 7.500 |
| Compression ratio at the cylinder | — | 3.009 | 2.914 | | | |
| Pressure loss from this stage's discharge to the next stage's | % | 3.5 | | | | |
| Compressibility Z at the cylinder suction | — | 0.9868 | 0.9657 | | | |
| Compressibility Z at the cylinder discharge (isentropic state) | — | 0.9841 | 0.9636 | | | |
| Isentropic exponent at the suction (real gas) | — | 1.2849 | 1.2866 | | | |
| Gas density at the cylinder suction | kg/m³ | 4.049 | 11.199 | | | |
| Mean piston speed | m/s | 4.00 | 4.00 | | | |

## RESULTS — DISPLACEMENT AND CAPACITY

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Swept volume rate (displacement) | m³/h | 1,763.8 | 642.7 | | | |
| Volumetric efficiency from clearance only | % | 80.66 | 81.68 | | | |
| Volumetric efficiency incl. leakage (cylinder suction basis) | % | 77.66 | 78.68 | | | |
| Overall volumetric efficiency at the line (inlet flow / displacem | % | 75.30 | 76.24 | | | |
| Capacity, mass flow | kg/h | 5,545.4 | 5,662.9 | | | |
| Capacity, actual inlet flow at the line suction | m³/h | 1,328.0 | 490.0 | | | |
| Capacity, standard volume flow | Sm³/h | 7,433.4 | 7,590.9 | | | |
| Flow the stage has to pass (stage-1 capacity less condensat | kg/h | 5,545.4 | 5,545.4 | | | |
| Stage capacity / flow it has to pass | % | 100.0 | 102.1 | | | |

## RESULTS — DISCHARGE TEMPERATURE, WORK AND POWER

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Isentropic discharge temperature at the cylinder | °C | 117.2 | 120.4 | | | |
| Expected discharge temperature (with the indicated efficiency | °C | 121.5 | 124.7 | | | |
| Margin to the discharge-temperature limit | K | +28.5 | +25.3 | | | |
| Isentropic work | kJ/kg | 178.67 | 171.16 | | | |
| Indicated power | kW | 289.7 | 277.5 | | | 567.2 |
| Brake power | kW | 305.0 | 292.1 | | | 597.1 |

## RESULTS — ROD GAS LOAD

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Rod gas load — compression | kN | 150.0 | 170.4 | | | |
| Rod gas load — tension | kN | 136.4 | 138.1 | | | |
| Compression load / rating | % | 68.2 | 97.4 | | | |
| Tension load / rating | % | 85.3 | 92.1 | | | |

## RESULTS — INTERCOOLERS

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Gas temperature into the cooler | °C | 124.0 | | | | |
| Gas temperature out of the cooler (= next stage suction) | °C | 38.0 | | | | |
| Approach to the cooling medium | K | 10.0 | | | | |
| Cooler duty (gas cooling plus condensation) | kW | 309.8 | | | | 309.8 |
| Water condensed | kg/h | 0.0 | | | | 0.0 |

## RESULTS — COMPARISON WITH PLANT READINGS (stages)

| Result | Unit | Stage 1 | Stage 2 | | | Total / machine |
|---|---|---|---|---|---|---|
| Measured − expected discharge temperature | K | +2.5 | +15.3 | | | |
| Volumetric efficiency implied by the measured flow | % | 73.09 | 72.52 | | | |
| Leakage / slippage implied by the measured flow | % | 7.56 | 9.16 | | | |
| Leakage / slippage allowance used | % | 3.00 | 3.00 | | | |

## RESULTS — COMPARISON WITH PLANT READINGS (machine)

| Result | Unit | Value |
|---|---|---|
| Measured mass flow into stage 1 | kg/h | 5,219.6 |
| Expected capacity of stage 1 | kg/h | 5,545.4 |
| Measured − expected flow | % | -5.9 |
| Measured brake power | kW | 600.0 |
| Expected brake power at the measured flow | kW | 562.0 |
| Measured − expected brake power | kW | +38.0 |
| Measured − expected brake power, per cent | % | +6.8 |
| Specific brake power — measured | kWh/1000 Sm³ | 85.755 |
| Specific brake power — expected | kWh/1000 Sm³ | 80.327 |
| Yearly energy cost of the power deviation | USD/yr | +25,586 |

## CAPACITY CONTROL STEPS

| Step | Unit | Stage 1 | Stage 2 | | | |
|---|---|---|---|---|---|---|
| Full load — capacity, % of full load | % | 100.0 | 100.0 | | | |
| Head end only (crank end unloaded) — capacity, % of full loa | % | 51.3 | 52.8 | | | |
| Crank end only (head end unloaded) — capacity, % of full loa | % | 48.7 | 47.2 | | | |
| Clearance pocket open — capacity, % of full load | % | 82.2 | 83.4 | | | |
| Full load — capacity, standard flow | Sm³/h | 7,433.4 | 7,590.9 | | | |
| Head end only (crank end unloaded) — capacity, standard fl | Sm³/h | 3,813.2 | 4,009.2 | | | |
| Crank end only (head end unloaded) — capacity, standard fl | Sm³/h | 3,620.2 | 3,581.7 | | | |
| Clearance pocket open — capacity, standard flow | Sm³/h | 6,110.8 | 6,328.3 | | | |

# Reciprocating Compressor Performance — Report



## WHAT-IF — STAGE-1 SUCTION PRESSURE AND SPEED

| Case | Level | Overall ratio | Std flow | Brake power | Last discharge T | Cost USD/yr | Change USD/yr |
|---|---|---|---|---|---|---|---|
| Suction -10.0 % | 5.400 | 8.333 | 6,566.4 | 556.4 | 129.5 | 374,808 | -27,450 |
| Suction -5.0 % | 5.700 | 7.895 | 6,998.9 | 577.1 | 127.0 | 388,816 | -13,442 |
| **Now (base case)** | **6.000** | **7.500** | **7,433.4** | **597.1** | **124.7** | **402,258** | **0** |
| Suction +5.0 % | 6.300 | 7.143 | 7,869.8 | 616.3 | 122.6 | 415,162 | +12,904 |
| Suction +10.0 % | 6.600 | 6.818 | 8,308.1 | 634.6 | 120.5 | 427,551 | +25,293 |
| Speed -10.0 % | 360 | 7.500 | 6,755.2 | 536.2 | 123.7 | 361,252 | -41,006 |
| Speed -5.0 % | 380 | 7.500 | 7,097.0 | 566.6 | 124.2 | 381,731 | -20,527 |
| **Now (base case)** | **400** | **7.500** | **7,433.4** | **597.1** | **124.7** | **402,258** | **0** |
| Speed +5.0 % | 420 | 7.500 | 7,764.1 | 627.6 | 125.3 | 422,829 | +20,571 |
| Speed +10.0 % | 440 | 7.500 | 8,088.8 | 658.2 | 125.9 | 443,442 | +41,184 |

## FINDINGS AND RECOMMENDATIONS

⚠️ **Correct soon**

Stage 1: the measured flow implies a leakage of 7.6 % of the swept volume against the 3.0 % allowance. Check the suction and discharge valves, piston rings, rod packing and any unloader or recycle valve.

⚠️ **Correct soon**

Stage 2: the rod gas load in compression is 97 % of the rating (170 of 175 kN). Check the relief-valve setting and the combined (gas plus inertia) load with the vendor.

⚠️ **Correct soon**

Stage 2: the rod gas load in tension is 92 % of the rating (138 of 150 kN).

⚠️ **Correct soon**

Stage 2: the measured flow implies a leakage of 9.2 % of the swept volume against the 3.0 % allowance. Check the suction and discharge valves, piston rings, rod packing and any unloader or recycle valve; the discharge temperature is also 15 K hotter than expected, which points to recirculation through

⚠️ **Correct soon**

The measured flow is 5.9 % below the expected capacity of stage 1. See the stage findings for the leakage each stage implies.

⚠️ **Correct soon**

The measured brake power is 38 kW (6.8 %) above the expected power for the measured flow, costing about 25,586 USD per year. Typical causes: leaking valves and rings (gas recompressed), high valve losses, fouled intercoolers raising the next-stage ratio, or a power-meter error.

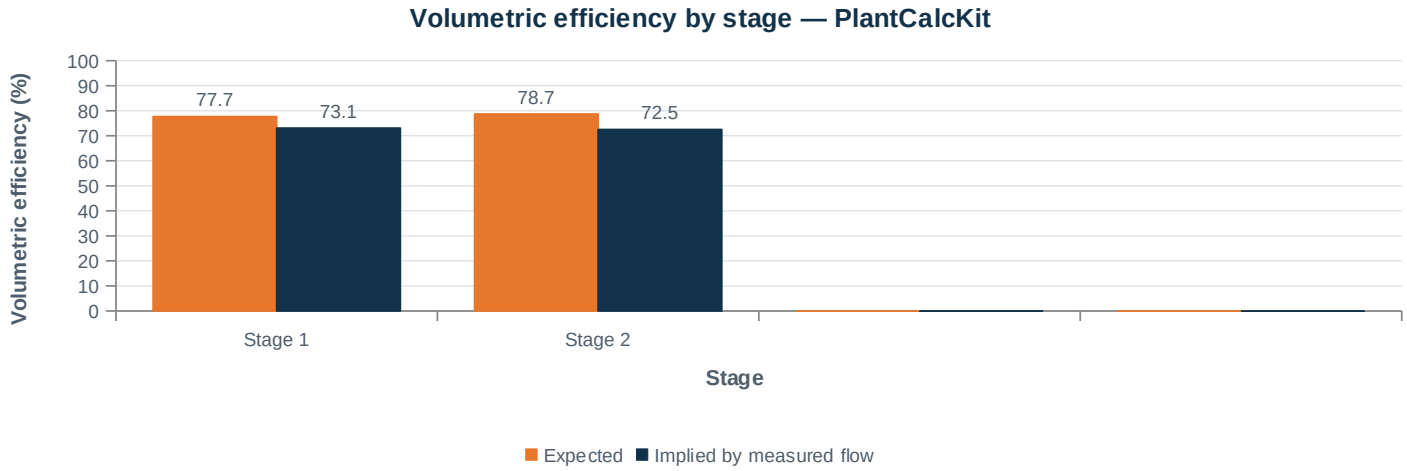
◆ **Opportunity**

Each 5 % higher stage-1 suction pressure would add about 436 Sm³/h of capacity for about 19 kW more brake power. Check the pressure loss in the suction strainer, scrubber and piping.

ℹ️ **Note**

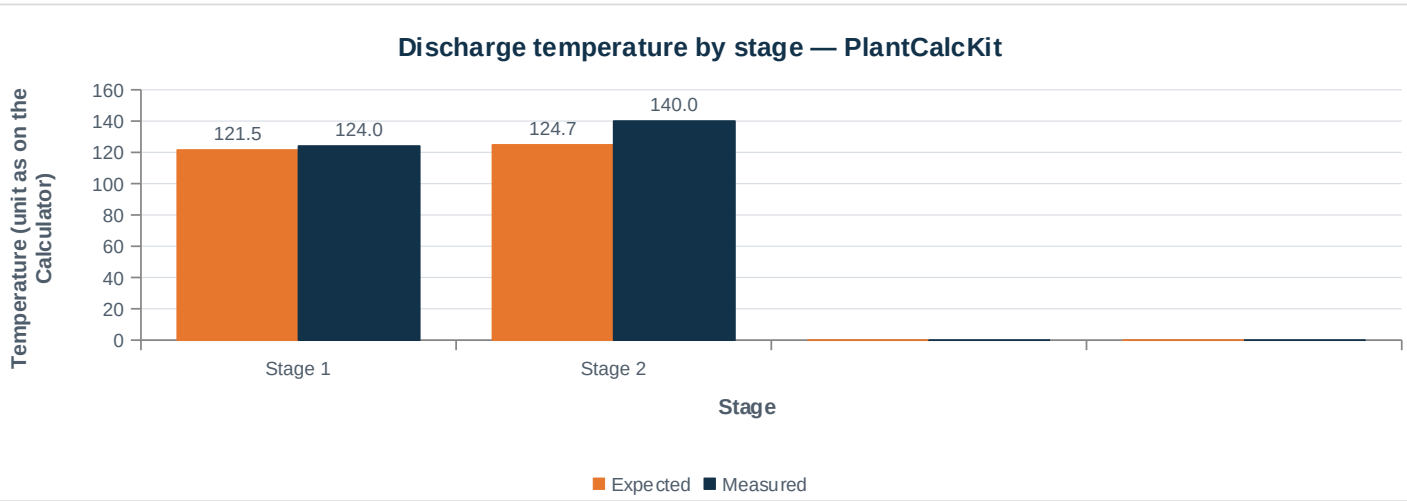
Default values are in use (added clearance when the pocket is open, suction valve + pulsation pressure loss, discharge valve + pulsation pressure loss, leakage / slippage allowance, intercooler approach limit, interstage pressure-loss limit, maximum discharge temperature, atmospheric pressure, indicated,

## CHARTS



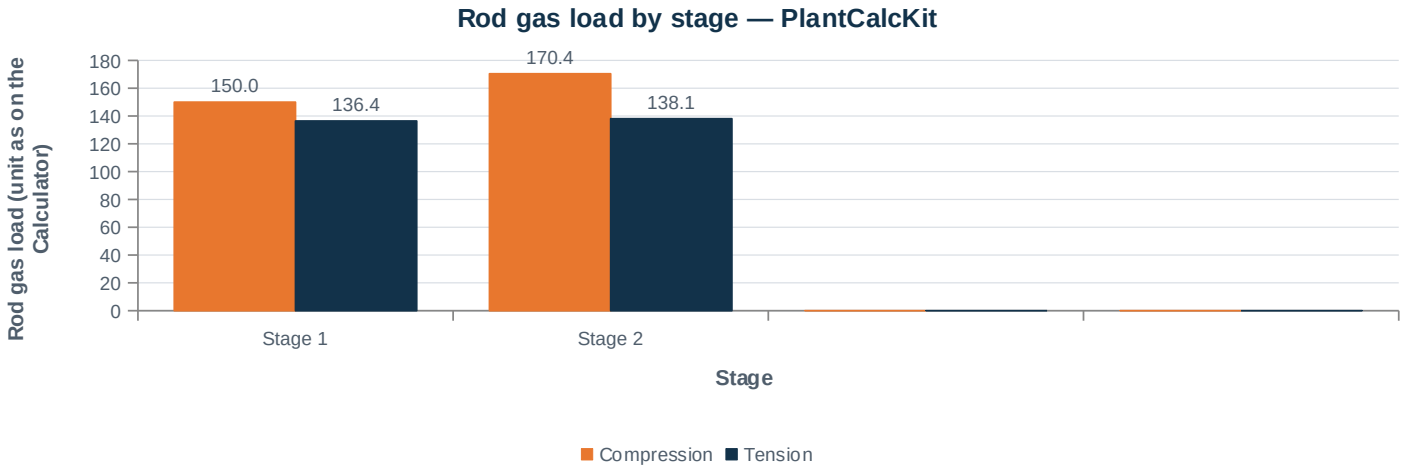

**Observations — volumetric efficiency**

[Write your observations here]



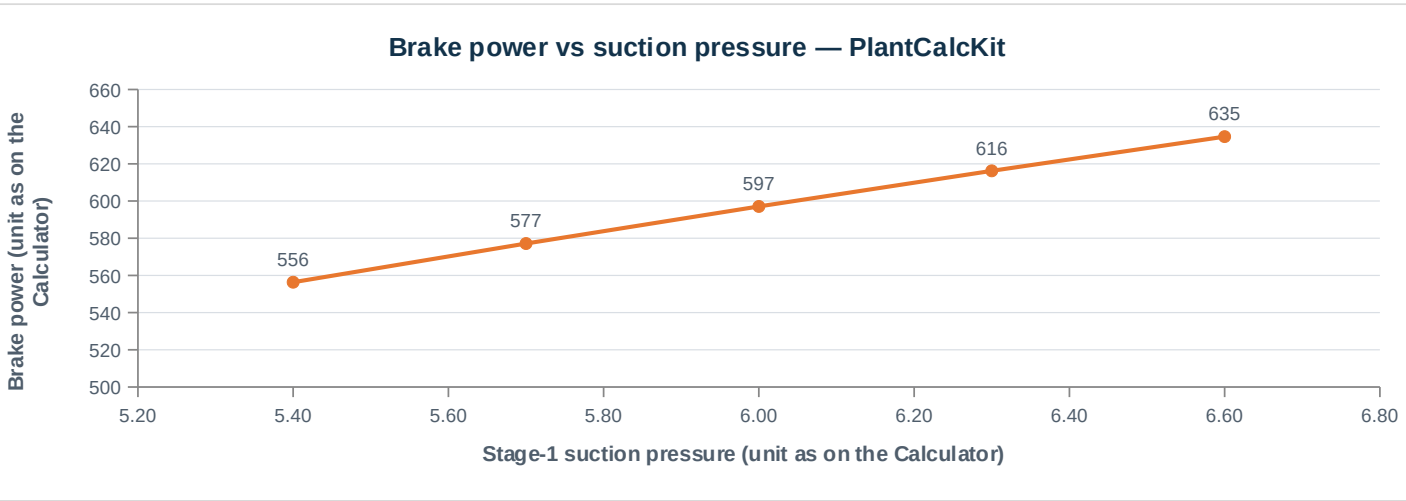

**Observations — discharge temperature**

[Write your observations here]




**Observations — rod gas load**

[Write your observations here]

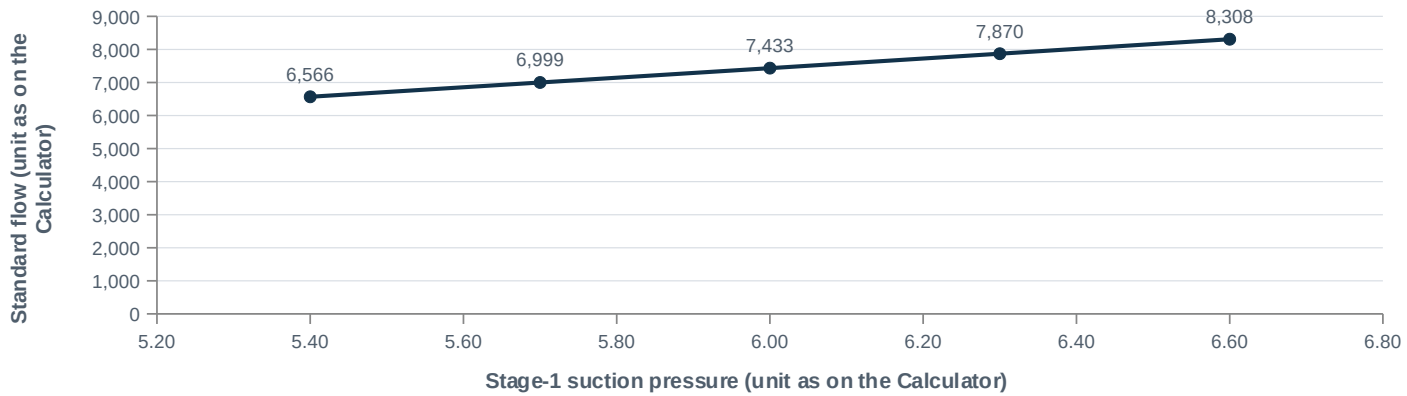



**Observations — suction pressure and power**

[Write your observations here]

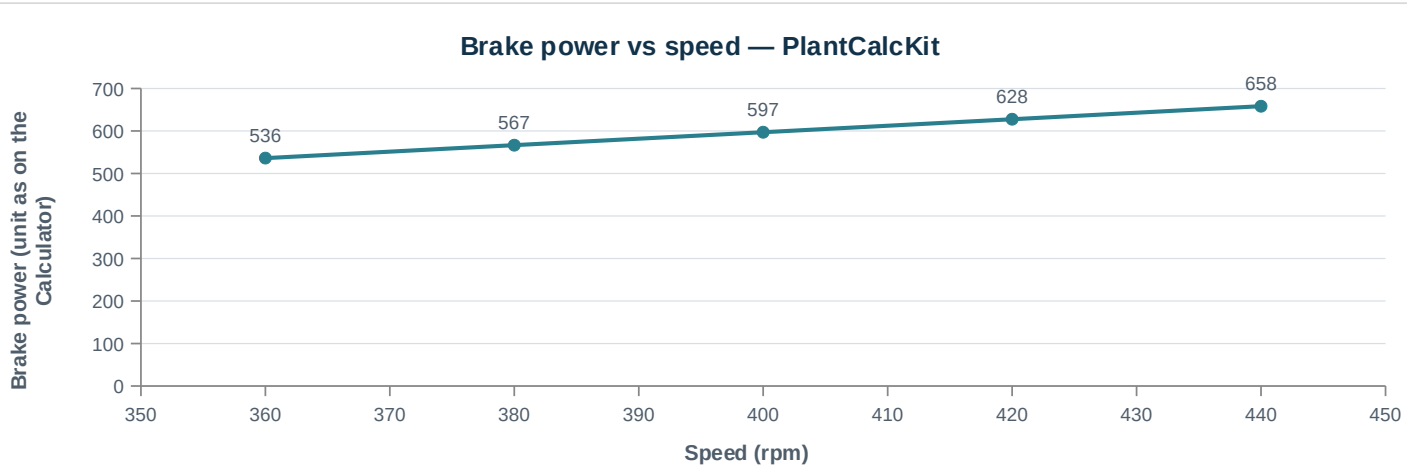
# Reciprocating Compressor Performance — Report

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**Observations — suction pressure and capacity**

[Write your observations here]




**Observations — speed and power**

[Write your observations here]

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