



## Worksheet HF04 & Training Record Power Formulas and Fundamentals

## Hydraulics Fundamentals

Email:

Course:

Provider:

### Learning Objectives/Expected Outcomes: (2-3hrs)

1. To appreciate the relationship between input power, system losses, and output power.
2. To perform simple system energy transfer calculations.
3. To appreciate the relationship between pressure, displacement, and torque.

### Previous Knowledge Required:

Students should have completed worksheet HF03 'Flow theories and formula' along with a basic knowledge of hydraulic components and systems.

### Terminology:

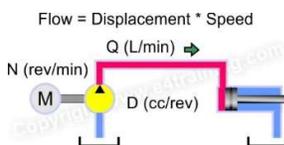
Power, torque, energy transfer, losses, efficiency, displacement, swept volume.

### Record of Achievement:



Click the email icon to post your results, once training is complete. Enter an LRS username and endpoint details or see [www.e4training.com/xapi/](http://www.e4training.com/xapi/) for free examples. Keep a record of any written work or worked calculations etc.

### Coursework investigation and instructional video



Study the 'Power, losses and torque' relationships at

[www.e4training.com/hyd\\_formula/power1.php](http://www.e4training.com/hyd_formula/power1.php) and [power2.php](http://www.e4training.com/hyd_formula/power2.php)

- Follow the complete path from power in, component efficiencies, losses, to output power.
- Understand the power is measured in kW.
- Appreciate the energy changes form from electrical, rotational, hydraulic, heat, and noise.
- To understand how to calculate the torque produced by hydraulic pumps and motors.

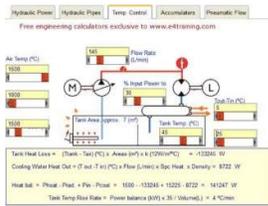
Estimated time: 30 minutes, skill level 4-6

Date complete:

Complete



## Virtual test rig experiments



Experiment with the 'power unit calculator' at [www.e4training.com/hyd\\_formula/power3.php](http://www.e4training.com/hyd_formula/power3.php)

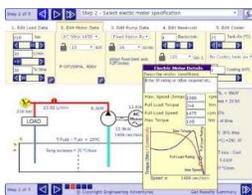
- Follow the suggested exercises and observations list below the simulation.
- Run the experiments, answer the questions, and click the buttons to see the answers.

Change the input and output settings and compare the results given with your own calculations.

Estimated time: 30 minutes, skill level 4-6

Date, score & time:

Tick when posted



Review the more complex performance calculations in the 'power unit design' simulation at [www.e4training.com/design\\_guides/designpu3.php](http://www.e4training.com/design_guides/designpu3.php)

- Observe how complex the loads can be.
- Observe how motor and pump efficiency varies with operating conditions
- Observe how tanks and coolers can remove the excess heat generated.

Review the energy transfer issues although these will be covered in more detail in later exercises.

Estimated time: 40 minutes, skill level 4-6

Record observations:

Tick when complete

## Practical & Coursework exercises



Raise and mass safely with a hydraulic jack. Calculate the work done, energy in and therefore the power required to complete the lift in the time taken [www.e4training.com/hyd\\_formula/power1.php](http://www.e4training.com/hyd_formula/power1.php)  
Compare the power of different individuals.

Estimated time: 15 minutes, skill level 4-6

Submit notes:

Submit calculations on separate sheet

### Output Power Calculations

$$P_{\text{load}} = \frac{p_2 \cdot Q_2}{600} - \frac{p_3 \cdot Q_3}{600} - \text{kW friction}$$



Based on your own equipment or using the scissor lift project as an example.

- Calculate the output power required to lift the load in a given time.
- Calculate the potential losses with flow set by pump displacement.
- Calculate the potential losses with flow set by an orifice.
- Calculate the input power required.

See project HW02 calculations [www.e4training.com/Hydraulic\\_projects/scissorlift1.php](http://www.e4training.com/Hydraulic_projects/scissorlift1.php)

Estimated time: 40 minutes, skill level 4-6

Submit calculations:

Submit calculations on separate sheet



## Interactive tutorial

Pressure generates a higher force on a larger cylinder

Load Force 1000 N 4000 N

Dia B = 22.4 mm Pressure = 100 bar

Area B =  $\pi D^2/4 = 400 \text{ mm}^2$

Force = Pressure \* Area = 4000 N

The FORCE of the second actuator is equal to the PRESSURE applied to the actuator multiplied by its effective AREA (cm<sup>2</sup>). Although the initial force is higher than the input force, the cylinder displacement is equal to the initial stroke travel in the line. For high displacement with hydraulic, dual power systems is that they only high power density capabilities can be transmitted with great flexibility throughout compact environments.

Complete the 'Formulas and Fundamentals' tutorial at [www.e4training.com/hydraulic\\_courses/microtutor1.php?wtformula](http://www.e4training.com/hydraulic_courses/microtutor1.php?wtformula)

Complete quick quiz at end and post results.

Estimated time: 10 minutes, skill level 4-6

Date, score:

## Interactive quiz to check and reinforce learning

Demonstration of quiz question formats

This is a QUIZ demonstrator. It will show all of the question layouts that are possible. This is a multiple choice question. Select only one of the correct answers.

Complete the 'Formulas and fundamentals' questions at [www.e4training.com/hydraulic\\_test2.php?Quiz - Hydraulics part 1](http://www.e4training.com/hydraulic_test2.php?Quiz - Hydraulics part 1)

Post result when complete.

Estimated time: 30 minutes, skill level 4-6

Quiz name, date, score:

## Key questions / Plenary

Can you explain the relationship between input power, system losses, and output power?

Can you describe what typical losses there may be in a hydraulic system?

Can you explain the relationship between pump displacement, pressure, and torque?

Record answers:

### And Finally:

Complete this worksheet and keep for your certification records. Submit any written coursework etc. to your training course provider.

### Follow-on Course Worksheets:

Potential follow-on worksheets include:

HF04 – Hydraulic power and torque fundamentals

For more specialist course worksheets visit

[www.e4training.com/hydraulic\\_courses/worksheets1.php](http://www.e4training.com/hydraulic_courses/worksheets1.php)