Practical 2P10
Materials Selection

What you should learn from this practical

Science

In this practical you will attempt to link the choice of material, processing routes and forming methods to the demands made by the function and environment of real engineering components.

Practical Skills

You will learn how to section polish and etch a wide range of materials. You will then have to deploy your knowledge of materials to research what they are likely to be and why they are used. Whilst you are materials scientists rather than engineers, it is important for you to be aware of the uses to which alloys are put, and the constraints the real world can place on material selection.

Communication Skills

You will learn how to put together and present a scientific poster to communicate your findings. This is a common way research scientists present their findings at conferences. We will discuss posters and good design at the start of day 2.

Overview of practical

You will choose 4 or 5 components from the engine (depending on their complexity), and examine them metallographically and in any other ways that seem appropriate. You will attempt to determine the material used, and any likely processing routes and forming and joining methods used to make the component. You will then consider why that particular material, etc., was used for the component.

Experimental details

Understand the engines

You are not going to make very much of this practical unless you have at least some idea of how an internal combustion engine works. You can ask a demonstrator for help but you may have to do some reading around either online or in the library.

Choice of component

One of the objects of the exercise is to look at a wide variety of components and materials. Choose four or five components with this in mind.

Try to choose ferrous and non-ferrous materials, components of both complex and simple shapes, subject to high stresses and low stresses, high temperatures, corrosive environments, etc. You might, for example, look at:

- Various parts of the carburettor - why are so many different materials and forming routes used?
- The piston / connecting rod / crankshaft system - including the bearings
- The cylinder / piston system - including the piston rings
- The gearbox assembly
- The engine housings and how they are connected together
- The various types of bearings used throughout - why are different types used in different parts of the engine?
- The cylinder head, camshaft, valve and guide assembly

This list is not meant to be exclusive, sometimes small high value components can be just as interesting as larger parts.

Before you make your final choice, think about what each component is meant to do, and what environmental conditions it will be subjected to (stresses, chemicals, heat, wear, etc.), and therefore what **you** might choose to make it from and how. Record this for each of your final choices and ensure your group expects to find a range of materials, with different environmental requirements.

Method of examination

Don’t rush into cutting up the component. First of all look at it as a whole; does the surface appear to have been machined, cast or what? Take photos (they will help with the poster, remember once you have started cutting there is no going back!)

General colour and appearance? Does it seem to have corroded? Is it magnetic?

Now think before you reach for the hacksaw. Is the surface likely to be treated? Is it likely to vary in any other way from place to place or with direction of section? Choose the cutting direction to examine this.

Now cut to a sensible size for polishing. How dense is it? This simple checks can provide a lot of useful information, measuring cylinders and water will be provided.
If necessary, mount the section in cold mounting compound or Bakelite. Grind and polish to a suitable surface finish (you should be fast after the last two practicals!).

Hardness testing can be useful to determine how the sample may have been processed. Hardness tables for different alloys are available (online and in the lab). This data can also be related to yield strength.

Try some etchants. The SD, TA and lab manager will help with this.

The ones that don’t work might help with identification, as well as any etch that **does** reveal the microstructure. Examine at low magnifications first what large scale variations in microstructure there might be. Then use the optical microscopes to study the microstructure. Take Pictures!. Choose the magnification(s) used to best show what is going on. Be prepared for the much finer scale microstructural scale of many real alloys (especially steels), compared to the “model” microstructures you have mostly looked at till now.

Safety note: Make sure you wear a laboratory coat, suitable gloves and eye-protection when etching your samples. Care must be taken when using hacksaws to section samples. Don’t start anything without training or discussing with a member of staff.

Making sense of it
Now go back to the ideas you wrote down **before** you did the examination. Is the material / heat treatment / forming route what you expected? If not, why not? If it is, what alternatives might have been used, and why weren’t they in this case?

Timetable

Day 1

- Research on motorbike engines.
- Choice of components.
- Sectioning and etching.

Days 2 & 3

- Discussion of poster presentation skills
- Etching and metallography.
- Writing-up.

What should be in the report?

There is no write up for this practical. Instead you will produce a poster which you will then present as a group. (Date: Friday of week 1 of Hilary Term)

What should be on the poster?

- **A brief introduction to the motor bike engine**
- **What your aims in this practical are**
- **Each component should have a section showing the results**
- **The conclusions you can draw from the results**

Questions you could try to answer for each component (not necessarily all these for all components but try to cover all of them somewhere).

I. What does the component do?
II. What are the principal “loads” on it (stresses, chemicals, temperature, wear, etc.)?
III. What other design constraints are there (shape, possible forming / joining methods, cost...)?
IV. What type of material would you expect?
V. What did your examination of the component tell you about:
   A. What material was used?
   B. What heat treatment it had?
   C. How the surface was treated?
   D. How the component was made?
VI. What alternatives might have been used? Why weren’t they?
VII. How might the component fail?
VIII. How could it be improved?

The poster will be assessed on both the technical content and the quality of the design and presentation. Key here is does it communicate your results effectively.