Trade of Toolmaking

Module 4:	Grinding
Unit 2:	Wheel Selection & Work Testing
	Phase 2

Published by

SOLAS
An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Table of Contents

Document Release History **3**
Unit Objective **4**
Introduction **4**
1.0 Identifying And Selecting Grinding Wheels **5**
1.1 Identification Of The Standard Markings On An Abrasive Wheel Blotter (Paper Washer) E.G. A 54 M 8 V 5
2.0 Analysing The Manufacturer's Data On The Grinding Wheel **6**
2.1 Abrasive types; aluminium oxide, silicon carbide 6
2.2 Grain size and numbering; coarse, medium, fine and very fine 6
2.3 Grade; Refers To Hardness Of The Bond E.g. Soft, Medium And Hard 6
2.4 Structure; Depends Upon Grain Size And Spacing E.g. Dense And Open, Effect On Cutting Action 6
2.5 Bond; Supports The Abrasive While Cutting E.g. Vitrified, Resinoid And Rubber 7
2.6 Appropriate Bond And Grit For Grinding Hard And Soft Steel 7
2.7 Multi-Point Cutting Action Of The Wheel 7
3.0 Identifying The Manufacturer's Instructions On Maximum Safe Speed **7**
3.1 Safe Maximum Speed For The Grinding Wheel 7
4.0 Ring Testing A Grinding Wheel To Detect Flaws **8**
4.1 Purpose Of Ring Testing A Grinding Wheel 8
5.0 Identifying Results Of Ring Testing **8**
5.1 Utilisation Of Data From Ring Test 8
Summary **9**
Suggested Exercises **10**
Questions **11**
Answers **12**
Recommended Additional Resources **13**
Reference Books 13

Document Release History

Date	Version	Comments
25/09/2014	2.0	SOLAS transfer

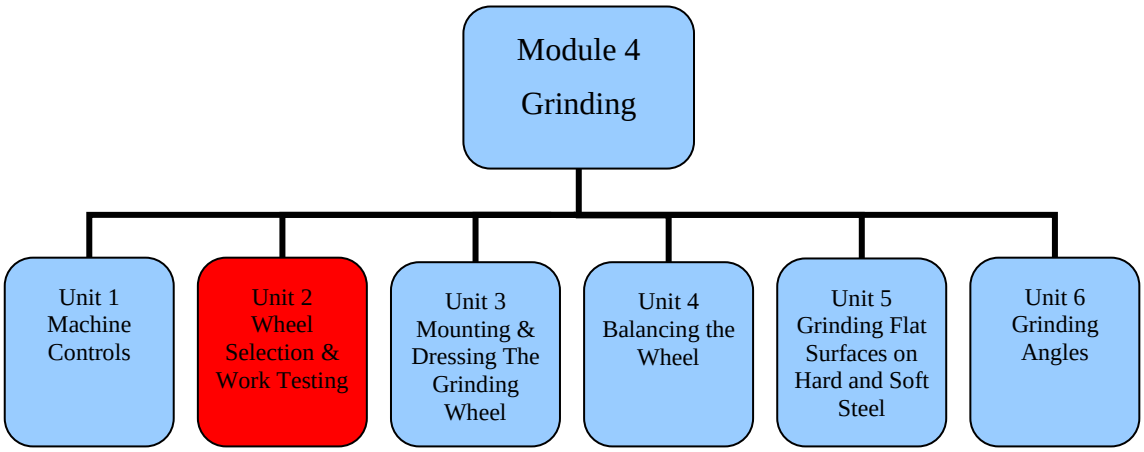
Unit Objective

On completion of this unit you will be able to select the correct grinding wheel, understand the manufacturer's data and test the wheel before mounting it on the machine spindle.

Introduction

Module four of this course covers grinding. This is the second unit in module four and explains how to interpret the manufacturer's data, which is written on the paper disk at the side of the grinding wheel. Different types of wheels are available depending in the material being machined and the surface finish requirements. The wheel is made up of abrasive particles, which are held together in a matrix called the bond. The abrasive type, size and quantity can be varied, as can the bonding material.

The manufacturing process of these wheels needs to be very tightly controlled, because of the very high running speeds involved and the danger of the wheel exploding, due to the centrifugal forces involved. Therefore the abrasive material and the bond material need to be mixed thoroughly and need to be dispersed evenly throughout the matrix.



By the end of this unit you will be able to:

- Identify and select appropriate grinding wheels for various applications on hard or soft steel.
- Analyse the manufacturer's data on grinding wheel blotter supplied with the abrasive wheel (paper washer).
- Identify with manufacturer's instructions on maximum safe speed for grinding wheels.
- Ring test a grinding wheel to detect possible flaws.
- Identify results of ring test and appropriate flaws that may be present.

1.0 Identifying And Selecting Grinding Wheels

Key Learning Points

Identification of the standard markings on an abrasive wheel blotter (paper washer) e.g. A 54 M 8 V

1.1 Identification Of The Standard Markings On An Abrasive Wheel Blotter (Paper Washer) E.G. A 54 M 8 V

There are many types of grinding wheels available, which have different abrasives, grain sizes, grade, structure and bond. The wheel type is identified by standard markings, which are written on the paper disc located on the side walls of the wheel. If for example, the wheel has the following markings, A 54 M 8 V.

A: *Abrasive* type, in this case Aluminium Oxide

54: *Grain Size*, which ranges from very fine to coarse abrasive grains. 54 is medium.

M: *Grade* of the wheel, which range from soft to hard bonds.

8: *Structure* of the wheel, where the abrasive can be dense or open. The range is 0 to 14.

V: *Bond Type*, is the material that holds the abrasive grains together, in this case Vitrified.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; characteristics*, p. 170.
ISBN-13: 9780750660730

2.0 Analysing The Manufacturer's Data On The Grinding Wheel

Key Learning Points

Abrasive types; aluminium oxide, silicon carbide. Grain size and numbering; coarse, medium, fine and very fine. Grade; refers to hardness of the bond e.g. soft, medium and hard. Structure; depends upon grain size and spacing e.g. dense and open, effect on cutting action. Bond; supports the abrasive while cutting e.g. vitrified, resinoid, shellac, silicate and rubber. Appropriate bond and grit for grinding hard and soft steel. Multi-point cutting action of the wheel.

2.1 Abrasive types; aluminium oxide, silicon carbide

The grinding wheel is made up of grains of hard substances, which are held together with the bonding material. The grain, which is also called the abrasive, does the actual cutting. The main types of abrasive are aluminium oxide and silicon carbide.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; abrasives*, p. 168.
ISBN-13: 9780750660730

2.2 Grain size and numbering; coarse, medium, fine and very fine

The grain is the abrasive and is identified as a number, the higher the number the finer the grain. The numbers range from 8 to 1200 and are grouped into the following categories: coarse, medium, fine and very fine.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; grain size*, p. 168.
ISBN-13: 9780750660730

2.3 Grade; Refers To Hardness Of The Bond E.g. Soft, Medium And Hard

The grade refers to the strength of the bond, which holds the grains in place. Grade ranges from soft to hard bonds. A hard grade wheel has more bond than a soft wheel and has a greater hold on the grains. A soft grade wheel has less bond and has less hold on the grains.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; grade*, p. 169.
ISBN-13: 9780750660730

2.4 Structure; Depends Upon Grain Size And Spacing E.g. Dense And Open, Effect On Cutting Action

The abrasive in the wheel can be dense or open. A wheel that has grains close to each other has a dense structure and a wheel where the grains are more spaced out is known as an open wheel.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; structure*, p. 169.
ISBN-13: 9780750660730

2.5 Bond; Supports The Abrasive While Cutting E.g. Vitrified, Resinoid And Rubber

The bond is the material that holds the abrasive grains together. The most common bonds are vitrified, resinoid and rubber.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; bond*, p. 169.
ISBN-13: 9780750660730

2.6 Appropriate Bond And Grit For Grinding Hard And Soft Steel

The *vitrified* bond wheels are the most commonly used wheel. They are strong, porous and are not affected by water or oil. The surface speed should not exceed 1900 m/min. The *resinoid* wheels are stronger and can be used where higher speeds are required, which can be as high as 4,800 m/min. These wheels can be very thin and are used as cut-off wheels. The *rubber* wheel can be very thin and are more flexible, they can also be used as cut-off wheels or for grinding small narrow slots. Again these wheels can be run at speeds of up to 4,800 m/min.

Ref: Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology, chapter 10, *Surface grinding; bond*, p. 169.
ISBN-13: 9780750660730

2.7 Multi-Point Cutting Action Of The Wheel

As mentioned above the grinding wheel is made up of abrasive grains, which are held together with the bond. The grains which are exposed on the surface of the wheel act as tiny cutting edges. As each of the grains wear, they break away from the bond and expose other grains.

3.0 Identifying The Manufacturer's Instructions On Maximum Safe Speed

Key Learning Points

Safe maximum speed for the grinding wheel, centrifugal forces.

3.1 Safe Maximum Speed For The Grinding Wheel

It is important to test the grinding wheel to ensure that it does not have a crack and that it is balanced before mounting it on the spindle of the grinding machine. Wheel balancing should only be performed by a qualified person. The grinding wheels are run at very high speeds, but it is important not to run the wheel beyond the maximum speed recommended by the manufacturer. When the wheel is running at high speed, centrifugal forces are exerted outwards from the central axis. If the wheel, for example, had a crack then these forces could cause the wheel to break up and disintegrate, which could cause serious injury and damage the workpiece.

4.0 Ring Testing A Grinding Wheel To Detect Flaws

Key Learning Points

Purpose of ring testing a grinding wheel.

4.1 Purpose Of Ring Testing A Grinding Wheel

Prior to mounting a new grinding wheel it is important to check for (i) broken or chipped edges (ii) cracks (iii) damaged mounting bushes and (iv) damaged compressive washers. It may not be possible to see a crack, therefore the wheel should also be checked by suspending it on a string and gently tapping the wheel with a wooded handle at several points. A clear ring sound should be heard at all times. A dull sound means that the wheel is cracked and should not be used. When mounting the wheel, steel flanges of equal size should be used, with compressible washers between the wheel and the flanges. It is important not to over tighten the locking wheel.

5.0 Identifying Results Of Ring Testing

Key Learning Points

Utilisation of data from ring test.

5.1 Utilisation Of Data From Ring Test

As explained above, a clear ring sound will be heard if the grinding wheel is free from cracks. A dull sound means that the wheel is cracked and should not be used.

Summary

Identifying and selecting grinding wheels: There are many types of grinding wheels available, which have different abrasives, grain sizes, grade, structure and bond. The wheel type is identified by standard markings, which are written on the paper disc located on the side walls of the wheel. If for example, the wheel has the following markings, A 54 M 8 V.

A is the *Abrasive* type, 54 is the *Grain Size,* M is the *Grade,* 8 is the *Structure* and V is the *Bond Type.*

Analysing the manufacturer's data on the grinding wheel: The grinding wheel is made up of grains of hard substances, which is the abrasive that actually cuts the workpiece. The main types of abrasive are aluminium oxide and silicon carbide. The grains are held together by a bonding agent, such as Vitrified, Resinoid, Rubber and Shellac. These grains project from the bond and when applied to the work act as thousands of tiny cutting tools. As the grains wear they will break away from the bond and expose other grains. For grinding steel, the type of wheel that can be used is aluminium oxide and a bond is vitrified clay. When grinding soft metals, such as aluminium or copper, do not use a fine wheel as it will clog quickly. It is important to dress the wheel regularly in order to restore trueness and clear the clogged cavities.

Identifying the manufacturer's instructions on maximum safe speed: It is important to test the grinding wheel for balance before mounting it on the spindle of the grinding machine. This should only be performed by a qualified person. The grinding wheels are run at very high speeds, but it is important not to run the wheel beyond the maximum speed recommended by the manufacturer. When the wheel is running at high speed, centrifugal forces are exerted outwards from the central axis. If the wheel, for example, had a crack then these forces could cause the wheel to break up and disintegrate, which could cause serious injury and damage the workpiece.

Ring testing a grinding wheel to detect flaws and identify the results: Prior to mounting a new grinding wheel it is important to check for (i) broken or chipped edges (ii) cracks (iii) damaged mounting bushes and (iv) damaged compressive washers. It may not be possible to see a crack, therefore the wheel should also be checked by suspending it on a string and gently tapping the wheel with a wooded handle at several points. A clear ring sound should be heard at all times. A dull sound means that the wheel is cracked and should not be used. When mounting the wheel, steel flanges of equal size should be used, with compressible washers between the wheel and the flanges. It is important not to over tighten the locking wheel.

Suggested Exercises

1. A grinding wheel has the markings: A 46 J 5 V, explain what it means.
2. What are the two most common types of abrasive used?
3. List the three most common bonds used in grinding wheels.
4. Select a grinding wheel from the rack and check it for cracks.
5. List three visual checks that you should perform before using a grinding wheel.

Questions

1. Explain briefly the structure of a grinding wheel.
2. In grinding wheel terms, what is the Grain?
3. What is the ‘Structure’ of the grinding wheel?
4. What is the ‘Bond’ in the grinding wheel?
5. Explain how a ‘ring test’ is performed on a grinding wheel.

Answers

1. The grinding wheel is made up of grains of hard substances, which are held together with the bonding material. The grain, which is also called the abrasive, does the actual cutting. The main types of abrasive are aluminium oxide and silicon carbide.
2. The Grain is the abrasive and is identified as a number, the higher the number the finer the grain. The numbers range from 8 to 1200 and are grouped into the following categories: coarse, medium, fine and very fine.
3. A wheel that has grains close to each other has a dense structure and a wheel where the grains are more spaced out is known as an open wheel. The abrasive in the wheel can be dense or open.
4. The Bond is the material that holds the abrasive grains together. The most common bonds are vitrified, resinoid and rubber.
5. The wheel should be checked by suspending it on a string and gently tapping the wheel with a wooded handle at several points. A clear ring sound should be heard at all times. A dull sound means that the wheel is cracked and should not be used.

Recommended Additional Resources

Reference Books

Black, Bruce J 2004, *Workshop processes, practices and materials*, 3rd edn, Elsevier Science & Technology.

ISBN-13: 9780750660730

Simmons, Colin H & Maguire, Dennis E 2004, *Manual of engineering drawing*, 2nd edn, Elsevier Science & Technology.

ISBN-13: 9780750651202

Bird, John 2005, *Basic engineering mathematics*, 4th edn, Elsevier Science & Technology.

ISBN-13: 9780750665759