

Focus On Welding/Finishing/Polishing

More than just scratching the surface.

By Peter Davies, managing director, Professional Polishing Services Limited.

Over the years, there have been number of attempts to produce standard descriptions of polished finishes but, on the whole, these have not been very successful. The use of description numbers has been confusing on occasions as, for instance, in the 1960's, prior to BS 1449, a "Dull Polish" was a No 1 finish, then it became a No 4 finish under BS 1449 and now in BS EN 10088-2 it is a 1J or 2J depending on whether produced on cold rolled or hot rolled base material.

In reality, most users have described finishes colloquially as a "Dull Polish" or "DP1" or "Satin" for many years and have been happy to accept the variations in finishes which have invariably been supplied from different sources. Sometimes this vagueness have backfired when material from different suppliers polished by different companies is used side by side on the same job.

On many products a BS standard is definitive. This is not so with polishing or even mill finishes as the standard usually describes only a method of achieving a finish – a process route.

For instance, in the new EN 10088-2 on table 6, 1J or 2J refer to the process route as "Brushed or Dull Polished" with the surface described as simply "smoother than ground" and under the heading "notes" the comment "Grade of Brush or polishing belt or surface roughness can be specified. Unidirectional texture – not very reflective". Hardly specific, this could cover almost every finish ever supplied under the Dull Polish label.

To use this sort of standard in isolation has a potential for confusion. We wouldn't specify a colour of paint as "a sort of blue that isn't very bright and has a bit of a metallic look about it". We would either choose from a colour chart or for standard finishes we would use a BS number which ensures a high degree of matchability from one maker to another.

The most important point of reference in table 6 of EN 10088-2 is note 5 which states: "Within each finish description the surface characteristics can vary and more specific requirements may need to be agreed between manufacturer and purchaser (e.g. grade of grit or surface roughness)". This particular paragraph is a catchall which, in my opinion, is saying to the specifier "here is a standard but ignore it and negotiate your own requirements to ensure you get what you want".

Any reputable polishing company will produce a sample card of a range of sheet finishes showing grits used and an approximate surface roughness reading expressed in microns Ra. Quality Control systems under BS EN ISO 9001:2000, will ensure consistency of match from sheet to sheet and batch to batch but it should be emphasised that the same general description "Dull Polish", "Satin Finish", 240-320 grit etc. from a number of suppliers may very well result in visually different finishes due to the variations in machines and process used.

Under most circumstances it is perfectly acceptable to choose the finish you require from a sample card providing you specify the polisher involved. It is generally not practical to provide sample cards showing plate finishes because of the weight involved, but the same basic care should be taken to ensure that as a fabricator you know what you are supplying.

Wherever there is doubt about the suitability of a standard finish or where there is a variation which may need to be matched in the future, the specifier should try to provide the polishing company with a sample which should be matched and given a designation which is easily traceable for future use.

For certain applications it is desirable to specify a surface roughness. This is usually shown on drawings as a figure in microns RA, although sometimes referred to as a CLA finish which, particularly if American, may be measured in micro inches. A simple visual appraisal is that one micron is approximately 40 micro inches and this would be in the mid range of surface roughness.

Surface measurement is a very comprehensive subject covered in depth by BS 1134 pt 1 1988 but the norm usually used in our industries is Ra which is described as “the arithmetical average value of the departure of the profile above and below the mean line throughout the specified sample length”.

Surface roughness is measured by an instrument such as a Surtronic which utilises a stylus travelling over a specified cut off length then displaying the results digitally on the instrument. Optionally this can be printed out in graph form or using the appropriate software coupled into a PC.

A number of industries – notably the nuclear industry – use a range of “N” numbers which relate to Ra values double up with each number thus N5 is 0.4 Ra, N6 is 0.8 Ra, N7 is 1.6 Ra and N8 is 3.2 Ra, all of course expressed in microns and all being nominal values not maximum. Care should be taken when reading drawings etc not to confuse an N4 with a No 4 finish or an N8 with a No 8 finish as they are totally different. The best illustration being that N8 is a coarse ground finish and No 8 is a bright polish!

Surfaces can also be measured in terms of reflectivity to cater for those applications when a low reflectivity level is required or to check that bright/mirror polishes are suitably bright. Values are expressed as gloss units with 1,000 being a perfect mirror. Measurement is carried out by an instrument which bounces a beam of light at a predetermined angle – usually 60 degrees and calculates the amount of light reflected back.

The specification of a surface roughness or reflectivity level, will ensure that surface finish meets a known measurement but will not ensure that a consistent look will prevail from polisher to polisher. Wherever a client specifies material to an “N” No, a required Ra reading, or a reflectivity level, this should, of course, always be supplied with a certificate from the polishing company.

All the standards referred to relate primarily to sheet and plate, but there is no reason why the basic principle should not be applied to other products, tube, section, bar etc.

Achieving The Finish

Having negotiated the minefield of which finish to specify, the decision has to be taken at an early stage as to the polishing route to be taken during the manufacture of a vessel or other fabrications.

There are two basic choices:

- 1) Manufacture from material which has been prepolished.

2) Manufacture and hand polish after fabrication.

The reality is usually a combination of the two!

If material is prepolished this is usually carried out by a specialist independent polisher such as ourselves or stockholders/processors with in house polishing facilities, although most stockholder/processors limit their range to sheet polishing avoiding the more specialist areas such as plate, profiles, box section etc.

Prepolishing of sheet, plate section, fittings etc on automatic or semi automatic machinery is a cost effective method of polishing and in most cases, the final product can be protected with a polythene protection tape which can be left on during the fabrication process.

Obviously material needs to be handled with a degree of care during assembly and fabrication, good housekeeping will ensure that fabricators do not damage the coating – and therefore the polished finish – during welding and assembly processes needing only to peel back the tape on areas adjacent to the weld.

Typically production routes are tailored to the product to be polished.

When carrying out any Dull or Satin type finish on **SHEET** up to 1600mm wide this is generally polished through machines known as “wide belt” machines, where the abrasive belt is wider than the item to be polished. The sheet is fed by rollers or conveyors through the machine and the finish is applied using a grit and grade of abrasive belt appropriate to the particular finish required.

Most wide belt machines have variable through feed and pressure to enable the operator to match a wide variety of finishes. Wide belt machines are generally used for cold rolled sheet production and are at their best when producing larger quantities of this material generally no thicker than 4mm.

Material is normally coated through an automatic or semi automatic laminating machine in line with the polishing machine.

When bright polishes are required on **SHEET** this operation is performed on a machine with an oscillating mop rotating at high speed over the sheet which passes back and forth under the head.

Polishing compound is applied to bring up the lustre which may take anything up to an hour depending on surface condition. Surface grinding may be carried out on grits right down to 800 grit to prepare the material for mopping but in general cold rolled material does not receive this treatment.

PLATE, up to 2000mm wide x 10mm thick in either Hot or Cold Rolled material can be produced to a range of Dull and Satin finishes via a heavy duty wide belt machine in a similar manner to sheet. However, due to the surface condition of the material [particularly Hot Rolled] this will usually involve a multipass operation on a succession of different grit belts to achieve the final finish. Material thicker than 10 mm is better produced on a narrow belt machine specially designed for the purpose. This type of machine has the ability to follow the variations in shape and flatness more often found on larger and thicker items. Because of the flexibility of the narrow belt process it is possible to carry out localised grinding to remove defects which would not be taken out by a wide belt machine.

The narrow belt travels along the plate – grinding or polishing depending on the abrasive belt being used. At the end of the stroke, the table moves back and the head travels in the opposite direction. This action is repeated in overlapping steps until the whole area of plate has been polished. Several passes may be

needed on a succession of different grit abrasive belts and although the process is quite slow, the end result is an excellent finish even on poor mill surfaces.

Although designed for the production of polished finishes on large plate – anything up to 7 ½ metres by 3 metres in our case – the construction of the machine allows it to cope with profiled shapes, small blanks, circles, strips or even large box section. Finishes from a coarse ground finish right through the range to an extra fine finish of 0.4 micron Ra or better can be produced by this method and we have three of these machines of various sizes to cope with virtually any size and shape of material.

LONG PRODUCTS such as bar, square or rectangular tube/section or round tube are often used to make components and fitments on many fabrications and like sheet or plate products it is possible to have almost all of these items prepolished.

Round tube or pipe is polished on a “centreless” machine through which the tube is rotated, whilst at the same time being pushed against the abrasive belt by an angled drive wheel which feeds the material through the heads in a spiralling manner.

The finish on the tube follows the circumference of the tube rather than running along the length as on a flat product. Because tube is usually polished on a multihead machine and a lot of heat is generated, a coolant is normally sprayed on the abrasive belts. A by-product of the coolant is that for any given “grit” finish the resulting appearance is often softer than on other products polished “dry” specifiers need to be aware of this when deciding on the finish to be used.

Square tube of section and rectangular section can be processed by a number of routes depending on the size and the quality of the base material.

Large box section, say 200x200, may be polished on a narrow belt plate polishing machine by lowering the table to the appropriate height and carrying out the same process as for plate. Smaller section, say 100x100, would be polished via a small wide belt machine – probably 600mm wide – in each case using a succession of different grit abrasive belts to achieve the desired finish.

Anything from around 60x60 or smaller would probably be polished on a multihead machine, where each head has water cooling to keep the product from distorting due to the high levels of heat generated by a number of abrasive belts in line.

Flat bar would follow the same principle in that the route taken would be dependent on the shape, size and surface quality of the product to be processed and because the grinding and polishing principles are basically the same, there should be no difficulty in achieving a match between different materials i.e. box section and plate, sheet and bar.

FITTINGS AND COMPONENTS used as part of a fabrication can often be supplied with a polish finish applied. Depending on the size and complexity of shape, items such as elbows, tees or bracketry which require polishing will usually be polished by the traditional “off hand” method where the skill of the operator is often the most important factor in achieving a good finish.

Machines such as spindle lathes or backstand abrasive polishing machines are used with the operator manipulating the fitting or component against the rotating belt or mop. Excellent finishes can be achieved on all sorts of complicated shapes, but each component has to be considered on merit and a decision taken as to the best route to follow to ensure that the finish matches the needs of the job both in terms of the operational requirements and of course aesthetically.

So in terms of prepolishing almost any product can be produced with a polished finish prior to fabrication.

All material can, of course, be purchased in mill finishes then cut, bent, welded and fabricated into the finished product leaving any polishing until the final stages. In general terms, whatever the final product, whether a vessel, an architectural item or any other item, it is almost certain that it will not be of a particular uniform shape and for this reason a wide range of hand tools will be required to carry out post fabrication polishing.

These will include an angle grinder, a small belt tool with attachments to enable the polisher to get into awkward spaces, a spindle type machine to enable the use of flap wheels and brushes, and probably a flexible drive unit which takes aggressive abrasives for use in dressing out sever localised defects.

To achieve a uniform finish on a large area and to blend in dressed welds around the fabrication is extremely time consuming and because of their small surface area the abrasives used tend to wear out rapidly, so consumables costs can mount up very quickly.

In general terms, the amount of time involved and the cost of consumables used on the hand tools makes this a very expensive option. Operators with the experience to produce a high quality are rare, as the skill and dexterity required suggest that in many cases an octopus is the best qualified candidate for job.

One of the biggest problems to overcome is that each area of a finished fabrication demands the use of a different hand tool and these each produce finishes with varying grain length and appearance so there is a real danger of the finished product looking something of a patchwork quilt.

Obviously those companies who regularly polish after fabrication have their methods and skills in place so it would be presumptive to tell them how to do their job.

Sufficient to say that the technology in hand tools and the consumables available are continually changing so if you do favour the post polishing method it is well worth keeping an open mind and reviewing your methods regularly.

Probably the most popular option favoured by many fabricators is to purchase the bulk of the material prepolished to the required to the required finish – or in some cases to an intermediate finish suitable for subsequent hand polishing – then carry out all the welding, fabricating and assembly to an almost completed stage.

Weld dressing, blending and the hand polishing of any marks or defects arising during fabrication is then much easier to carry out as the bulk of the surface removal has been carried out by the prepolishing operation.

As mentioned earlier, the bulk of the area of prepolishing would have been protected during the fabrication process to minimise damage.

This final operation is usually well within the scope of most fabricators with general engineering skills and so tends to be the logical route to take as it will generally provide the shortest production time and prove to be the most cost-effective.

SUMMARY

In summary, there are seven areas which are of particular importance with regard to the specification and use of polished finishes.

1. If you are involved with design, consider carefully which finish most matches the operational requirements both functionally and aesthetically.
2. As a fabricator or stockholder you should have a clear understanding of what is being specified as different terminology may be used.
3. Don't rely solely on British Standards because of their limitations. Different companies may interpret in different ways.
4. If a sample can be obtained of the finish required, this will enable the polisher to offer a close match.
5. If a sample is obtained and matched, ensure a clear reference is agreed so the finish can be replicated in the future.
6. If an Ra or Gloss reading is specified and you have no means of verifying the reading, a certificate should be obtained.
7. When deciding whether to fabricate from mill finish with subsequent polishing or to purchase prepolished material, consider the ease or difficulty of the task of subsequent blending and polishing.

Money spent on prepolishing will often be repaid many times by the saving on labour and consumables at the final stages.

If all the implications are considered from the outset and the people from different disciplines work together, from the user/specifier through designer, supplier, polisher and fabricator, the final result will be totally integrated product which will give the user many years of faithful service.