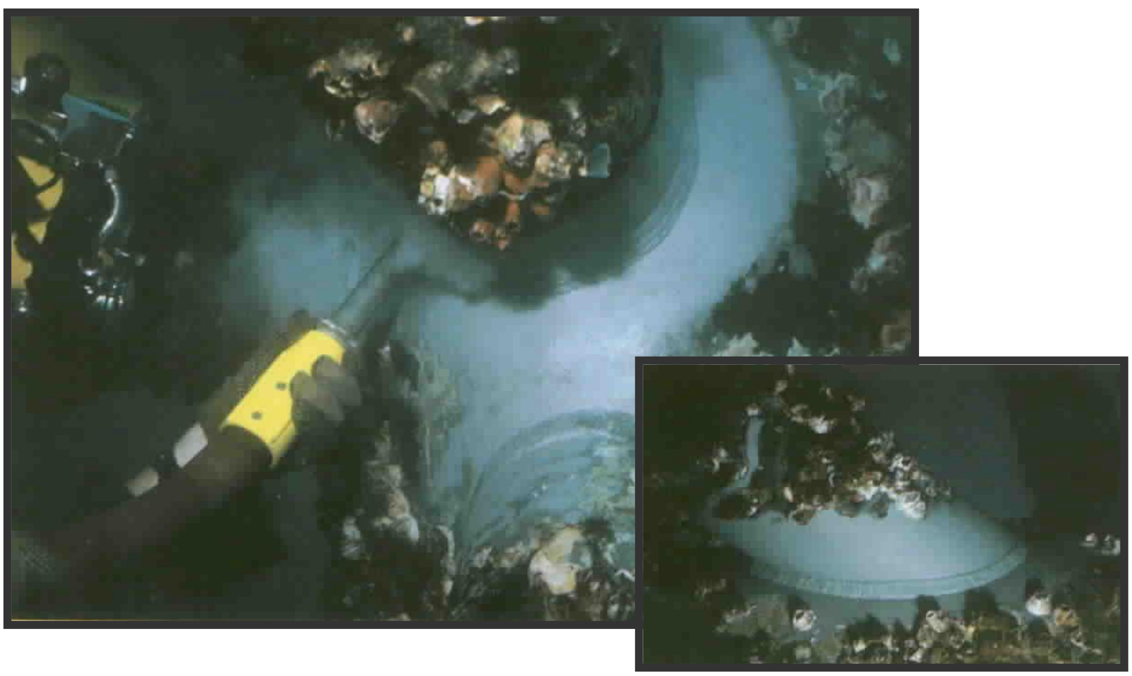
TECHNICAL ASPECTS OF SUB AQUABRADE

Advantages of Subaquabrade

- It has averaged better than 15 times the speed of cleaning of most high pressure slurry jetting machines.
- It leaves a clean, non-reflective matt surface to SA2.5 standard.
- Low grit usage typically 1 kg per minute.
- It is verysafe for the diver working and for other divers and equipment in the vicinity of the work.
- Simple to deploy
- It is very easy for the diver to use one handed..
- Low noise underwater does not impair communications between the diver and topside control
- Being vibration free and having an inconsequential thrust it makes an ideal tool for R.O.V. mounting.
- It is equally capable of cutting through a hard substance such as concrete or calciferous marine deposits as it is in removing soft bitumen, grease and mud deposits, rubber coatings, etc.
- Performance does not diminish with depth.It is equally effective and will produce the same cleaning rate working at 200 metres depth as at 2 metres depth.



COMPARISON OF CLEANING METHODS

A. SubAquabrade Low Pressure Abrasive Slurry Cleaning

The Liquabrade system had been invented and developed in order to achieve certain specific objectives. There had been much research by both the Paint Research Association and by N.A.C.E. into the causes of the premature failure of coatings on offshore structures, which had highlighted as the main culprit the traditional grit blasting and water jetting methods of surface preparation and cleaning, because of their inability to remove all of the contaminants and residues from the surface being cleaned, coupled with the irregular and unsatisfactory profiles left after cleaning.
The way in which the established surface cleaning industry had tried to tackle this problem was to throw more grit or water or slurry at the surface at higher and higher pressures, with little significant improvement. A different solution was sought, which resulted in Liquabrade, which propels a “liquid abrasive” onto and across the surface, cutting through and lifting all of the coatings and contaminants from the surface and out from all of the surface pits and crevices as well, and imparting a controllable variable profile.

B. Dry Grit Blasting

Conventional dry grit blasting at the normal topsides nozzle pressure of 8 to 10 bar, or 100 to 140 p.s.i.g., can be very effective in shallow waters, giving a reasonable rate of cleaning and capable of leaving a good matt surface finish on steel to SA2-1/2 standard – or “near white metal". The equipment used is either a conventional "topsides" grit blaster or a high pressure rated version, and it is consequently easy to handle in shallow waters.

Their most effective zone seems to be between 5 ft (1.5 metres) M.W.D. and 50 ft (15 metres) to 75 ft (23 metres), depending on the make. Within this zone they need an air compressor rated around 400 c.f.m. or 680 m^3/hr, and they consume up to 800 kgs of grit perhour.

There appear to be difficulties in obtaining good results in the splash zone, but the biggest problem comes when going deeper. Although different manufacturers make various claims in their literature that they are capable of operating at depths down to 600 ft (183 metres), it is to successfully clean any welds successfully below 180 ft (55 metres) with this method.

On top of the normal increases in compressed air volume and pressure required, which one would expect as one goes deeper in order to overcome and work in higher ambient pressures, there are two other resistances to be overcome which also increase with depth.

The grit which is entrained in the air-stream is propelled forwards with increased velocity through the venturi nozzle, while the dry air expands and decelerates rapidly. As it leaves the nozzle the slowing air forms large bubbles which follow a natural upwards incline.

Thus the grit particles rapidly reach the meniscus interface between air and water*, and expend energy in breaking through this barrier. The second energy loss is caused by the film of air which the grit carries with it away from the main bubble, adhering to its irregular surfaces, causing increased drag as the particles pass through the water.

These losses can be countered by using bigger and more powerful compressors, but with rapidly diminishing effectiveness, while at the same time grit consumption rapidly increases.

A major loss of diver’s time in the water is through blockages caused by damp grit. In these systems the grit is housed in a pressurised container which de-pressurises each time the machine is stopped. When grit blasting on the surface, this is no problem, but deep underwater there is a pressure differential at the nozzle which changes from an overpressure to a negative pressure, creating a siphon effect and venting damp air back through the hose, and out through the pressure release valve on the grit container, depositing moisture into the grit on its way. At depth this siphon effect will cause a reverse flow of water up into the grit container, flooding the grit container.

C. High Pressure Water Jet Blasting

Again, this is equipment primarily designed for topsides cleaning work, modified to enable its use underwater. The equipment itself is quite simple, commonly comprising a diesel engine driven high pressure water pump, rated to deliver between 5 and 12 gallons per min. (23 to 55 litres per min,) of water at pressures ranging from 7,000 to 60,000 pounds per square inch (483 to 4,137 bar).

At such pressures as these a very high thrust is generated by the water jet stream leaving the nozzle, even in air on the surface, necessitating the use of a fair amount of strength when handling the gun. Its use can leave the operator physically exhausted after even a short period.

Underwater, this problem is exaggerated because of the resistance of the sea water and because a diver will often have nothing firm to stand on or to brace himself against. When bringing the jet into close proximity to the surface to be cleaned the reactive force from that surface increases, pushing the operator back with great force

In an effort to combat this, retro jets are fitted to create an equal thrust in the opposite direction, however, that means using up around 50% of the available energy of the pump. It also necessitates the use of safety rigging and harness, thus a lot of time is used in setting up to work on one area of a weld, and then in re-positioning as the diver moves round the weld.

In order to prevent a rapid dissipation of energy from the jet, due to resistance of the water, the jet is usually kept to a very tight stream using a narrow nozzle, thus concentrating the power to enable the jet to cut through hard coatings, shells and so on. The problem here, is that the cutting or cleaning is in very narrow bands, commonly only 2 to 3 mm wide. Although such a water jet will slice through a rubber suit causing severe injury, it is not so effective on very hard surfaces, or on soft tarry or greasy surfaces, thus to clean a large weld area to near white metal can take a very long time.

It is, however, quite effective for bulk marine growth removal, where the aim is to remove the bulk of the growth from a jacket leg, in order to reduce drag, but leaving the base coating reasonably intact.

To try and overcome the problem of diver injury, "dead man's" safety shut-off handles and long extended lances have been devised, theoretically making such accidents impossible, but unfortunately they still occur.

To compound these problems, the noise generated by the jet underwater makes communication between the diver and the surface control cabin almost impossible while the jet is operational, again often leading to long delays and sometimes highly dangerous situations.

D. High Pressure Slurry Jet Blasting

In an effort to speed up the cleaning rate and cutting effectiveness of high pressure water jetting, various systems whereby an abrasive grit can be entrained into the water jet have been devised. There are 2 main types in everyday use, with some operators favouring one while another will favour the other, with apparently little to choose between either on performance or reliability.

One device uses a container of dry abrasive particles, sometimes pressurised, sometimes not, located next to the pumpset; while the other uses a container housing a slurry of water and abrasives, which has to be continuously agitated in order to keep the abrasives in suspension.

Both systems rely on a vacuum, created by the water jet passing through a venturi nozzle or similar device located adjacent to the cleaning nozzle underwater, the pressure differential thus established between this device and the abrasive container inducing the abrasive to flow down to and through the device and into the water stream, when it is then ejected by the streams velocity through a small nozzle, as with the standard water jetting machines previously described.

The introduction of an abrasive into the water jet makes this a much more effective tool for cleaning, as it can cut through not only the toughest of epoxy coatings or concrete but steel as well, and it carries a much higher risk of diver injury. However, on thick bitumen and muds it is not very effective.

Nozzles and hoses wear out with alarming rapidity and blockages occur frequently, resulting in an even higher proportion of the divers time underwater being wasted.

E. . Hydraulically Powered Wire Brushes

With one or two notable exceptions, wire brushing is rarely used these days for complete weld area cleaning as it is very slow and laborious, particularly where good quality coatings have previously been applied, or where hard calciferous deposits have formed.
Coupled with the length of time taken to reach a reasonably clean state, there is a major problem with light reflection and glare, as this method usually leaves a highly burnished or polished effect. It is also quite easy to close over cracks and inclusions.

Wire brushing is most commonly used for touching up previously cleaned areas which have been left for a time, as it is a relatively compact piece of equipment capable of being run off most offshore power supplies.

Hydraulic hoses are often heavy, and difficult to handle and deploy, but once on station under water the tool is not too difficult to use. The biggest cause of accidents with this tool appears to be due operator inattention.

Background to Sub-Aquabrade

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The way in which the established surface cleaning industry had tried to tackle this problem was to throw more grit or water or slurry at the surface at higher and higher pressures, with little significant improvement. A different solution was sought, which resulted in Liquabrade, which propels a “liquid abrasive” onto and across the surface, cutting through and lifting all of the coatings and contaminants from the surface and out from all of the surface pits and crevices as well, and imparting a controllable variable profile.

It was discovered that by varying the proportion of water to abrasive grit it could dramatically affect performance. Also that the tolerance to flow variations, so as to obtain the most beneficial effect, is quite low. It was found that if water was introduced into a grit laden airstream sufficiently to encapsulate every grit particle and in such a manner as to ensure that each particle was thoroughly wetted, then the bulk of the air which had been observed adhering to grit, discharged from a dry grit blaster underwater had been displaced, reducing the "drag" effect. Also, the "meniscus” resistance to a dry grit particle discussed earlier, was greatly reduced when the particle was first wetted, due to the different interaction of the two surfaces.

It was also found that the use of warm and/or fresh water had a marginally beneficial effect, although not enough to provide any commercial benefit.

However, by introducing a further small volume of water into the mix and at the same time ensuring a sufficient but not excessive agitation of the ‘mix’ prior to reaching the nozzle, the large air bubbles, previously seen occurring with dry grit blasters, could be dispersed and an "air mist" effect generated instead.

At that point peak performance was achieved, and it wasfound that with nozzle pressures as low as 35 p.s.i. (2.4 bar) over the ambient water pressure, would remove quite tough coatings, barnacles, bitumen and so forth, at average rates of around 4 square metres per hour.

Too much water injected into the grit has the effect of dissipating energy and thus reducing efficiency and slowing the work down, while if too little is used performance can drop by at least 50%.

It was also found that too great a quantity of grit introduced could have a seriously detrimental effect, much more so than had been expected, thus it became necessary to control the natural tendency for grit flow to increase as one increased the operating pressures with depth, in order to obtain the optimum balance.

At the time of the first presentation of this paper to the 1990 Oil, Gas, & Petrochemical Seminar in Abu Dhabi, SubAquabrade had worked for 2 seasons in the harsh environments of the North Sea, with up to 10 machines operational at a time, without one reported loss of divers time in the water due to a major equipment breakdown.

After exhaustive tests, and consultations with the various safety bodies responsible for offshore and divers safety, it was decided not to fit a dead mans handle for Sub Aquabrade At 50 p.s.i. (3.5 bar) which is the general nozzle pressure being used in the field, it is almost impossible for a diver to injure himself with SubAquabrade.

Perhaps the most remarkable aspect of SubAquabrade, however, is that despite these very low pressures, it is also proving to be a remarkably efficient tool for cutting concrete weight coat from undersea pipelines. Also for then removing the thick bitumen coating which is normally applied for corrosion protection beneath the concrete.