Developing an Effective Mask / Respiratory Protective Equipment (R.P.E.) Cleaning and Disinfection Programme

Introduction

This report is designed to give an overview of suitable methods, equipment and chemicals for effective cleaning and disinfecting of Respiratory Protective Equipment (R.P.E.). The detail of servicing inspection and testing is not covered in depth as this will depend on the R.P.E. manufacturers requirements.

Everywhere respiratory protective masks and breathing apparatus are used, there remains ongoing challenges to the maintenance regime, for ensuring equipment is safe and operational.

During use, masks will become soiled with exposure to the surrounding environment. Typical soiling can include dirt, oils, grit, chemicals, and grease. In some cases, masks may be exposed to contamination which is dangerous at low levels which may need special processing depending on what the contaminant is - examples of this are asbestos fibres, radioactive particles, hazardous contagions, and harsh chemicals. Soiling which is visible is easier to clean but remember that not all soiling will be easily visible.

Methods for cleaning need to be optimised to minimise downtime.

It is also important to understand there are hazards from within. Masks are fitted to the face in proximity to the breathing zone. Exhaled moist warm air and sweat from the face can contaminate the mask from within. In addition to this being unhygienic, where a wearer is suffering from a contagious illness, even if it is simply a common cold, this infection can be passed on to others, unless proper disinfection occurs between uses (see Fig.1). Primarily this issue is seen where masks and equipment are pooled or communal. Consideration needs to be given to those who are involved in the maintenance of masks also as they are potentially exposed.

Fig. 1

A successful programme for RPE cleaning and disinfection relies on 3 key areas (Fig.2)

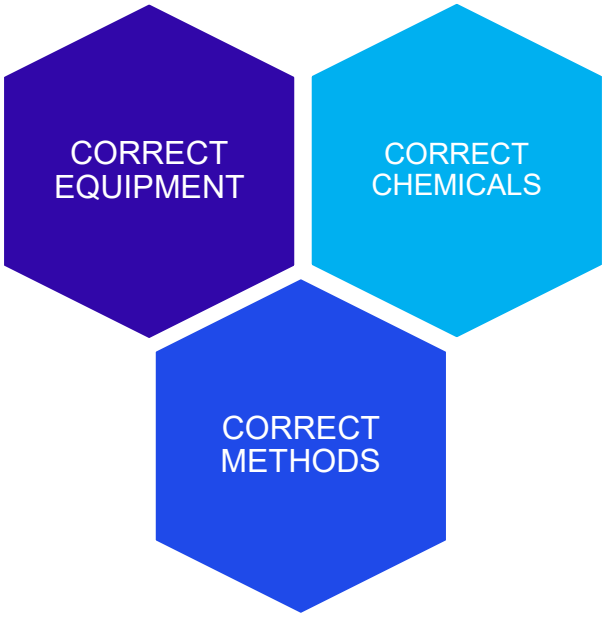

Fig.2 A Successful Cleaning and Disinfection Programme

Types of R.P.E.

The following shows the range of re-usable R.P.E. which requires processing:

Fig.3 L-R Half Mask with in-built filter media, Half Mask with detachable filter, Full Face Mask

Fig. 4 L-R Powered Air Respirator, Compressed Air Breathing Apparatus

Key Considerations in developing an effective Cleaning and Disinfection Programme

1. **Protect the equipment from unnecessary exposure to soiling/ contamination.**

Protecting equipment from exposure to soiling or contamination can sometimes be achieved – examples are chemical splash hoods and disposable over-suits.

Protecting equipment will give the advantages below:

a. The equipment will take considerably less time to clean after use.
b. The equipment will be protected from harsh and degrading soiling which can affect the integrity of the equipment.

Fig.5 A chemical over-hood will not only provide splash protection during use but prevent damage and minimise cleaning to the respiratory equipment.

Fig.6 The exposure to a hydrocarbon product of this hose meant that it delaminated and burst causing loss of air to the user.

2. Selecting respiratory equipment Designed for Maintenance (DFM) and Cleaning

When selecting masks and apparatus, it is important to ensure that as part of the process the ease of dis-assembly and re-assembly is analysed. A well-designed mask will be easy to strip down with minimum tools and save considerable amounts of time when processed through cleaning and disinfection.

3. Assess the likely soiling.

It is important to understand the products the apparatus is being exposed to. Datasheets and COSHH Assessments will indicate the risks with products. Reducing exposure of product to the wearer will also reduce soiling on the equipment. Assessment of the soiling should consider what the product is and the amount of soiling.

Typical soiling/ contamination in industries which commonly use respiratory protective equipment are as follows:

Industry	Soiling
Tank Cleaning/ Oil industry	Hydrocarbons
Chemical industry	A huge range of chemical products including organics, inorganics, and acids
Pharmaceutical industry	Active component particulates, general particulates and chemicals, Microbial/ Biological contamination
Fire and Rescue services	Carbon deposits, and any soiling depending on what fires are being fought.
Healthcare	Microbial / Biological contamination
Nuclear industry	Radioactive particulates
Asbestos removal industry	Asbestos fibre
Lead / Metals industry	Metallic particulates

4. Selection of Appropriate Cleaning chemicals

It is important to understand the difference between cleaning and disinfecting. Cleaning is the removal of soiling, whereas disinfecting is the process of destruction or inhibition of disease-producing microbial growth.

Important considerations are:

a. The agent needs to be effective against the soiling.
b. The agent needs to have no degrading effect on the integrity of the equipment.

Generally, the more effective the cleaning agent, the more likely it will have an adverse effect on the equipment. Chemical solvents such as acetone, and paint thinners should not be used as they will likely degrade equipment very quickly.

Rubber / TPE Elastomer parts will tend to be most sensitive to cleaning chemicals – many parts on a mask are made from these materials.

Plastic Parts – typically these are made from resilient plastics, but will be affected by solvents and aggressive chemicals, unless compatibility is properly proven.

Pneumatics assemblies and hoses, external surfaces - care needs to be exercised being made of rubber / elastomer compounds and they can degrade on exposure to unsuitable cleaning chemicals. O-rings and seals should be treated with special care and not normally subjected to any chemicals.

Harnesses / padding belts (structural) – typically these would be washed in a washing machine. The manufacturers recommended operating temperature needs to be observed. As these are load bearing normally, they should be washed with a neutral PH washing powder.

Harnesses / padding, (non – structural) – Washing machines are best utilized for washing these.

5. Selection of Appropriate Disinfectant

Strong disinfectants will eliminate infectious microbial growth but may degrade particularly rubber parts of masks and apparatus. Finding a suitable disinfectant that has biocidal efficacy and will not degrade the mask is very important. Manufacturers of respiratory equipment may recommend suitable disinfectants, or alternatively some specialist cleaning/ disinfection chemical suppliers will provide data on the range of respiratory equipment their agents are safe to use with.

It is important that not only an effective disinfectant is used, but also an effective method, particularly as the microbial growth is not visible. Efficacy of a disinfectant will depend on the concentration of the chemical (or dilution ratio) and duration of time it contacts the equipment. Usually, the chemical supplier will be able to provide efficacy data.

6. Washing and Disinfecting Equipment suitable for R.P.E.

Washing or disinfecting equipment must not damage R.P.E. – ensure any electrical components are treated with care and pneumatics equipment is not flooded with chemicals in the process. Usually, equipment suppliers will be able to recommend what R.P.E. their equipment is safe for use with.

Washing /laundry Machines

Both Industrial and Domestic washing machines are acceptable for washing equipment harnesses and belts. Ensure operating temperatures for apparatus are not exceeded.

Mask Washers

Several manufacturers of commercial dishwashers have developed mask washers. These are very similar to commercial dishwashers, but they operate at lower temperatures due to the maximum operating temperatures specified by most manufacturers.

Apparatus Washers

Like mask washers, these will wash pneumatics and harness parts. They will contain pneumatic connections so the equipment can remain pressurised during washing and prevent ingress of water to the pneumatics. However, their effectiveness is limited on heavy soiling.

Fogging Cabinets

These are a new concept in processing masks. A cleaning solution or disinfectant is vapourised into the cabinet for a set amount of time, the masks are coated in a film of moisture. The masks are then withdrawn from the cabinet and dried off. The benefit of these can be seen in reduced drying time, as minimum solution is involved, there is no chasing around the water which always is left in the mask from immersion or any of the other mask washing machines.

Drying Cabinets

Drying cabinets use warm dry air to expedite drying of masks and apparatus over air drying. They are effective on apparatus, but with masks they will often leave residues of water still which then need to be dried by hand and can sometimes leave 'tide marks' on the mask. Although a drying cabinet speeds up the drying process, it still takes a long period of time to effectively dry masks.

7. Suitability of Non-Chemical Disinfection Equipment

The following are alternative disinfection methods:

a. Steam

Steam sterilisation works on the principle of submitting equipment to high heats without pressure. This does not necessarily work.

b. Autoclave

Autoclaves are used for sterilisation of equipment. Since they submit equipment to high heat steam and pressure, they are not suitable for cleaning respiratory equipment.

c. Ultra-Violet (UV) Disinfection

UV light of certain frequency band is effective in sterilizing of equipment. UV is very effective where the light shines, and not effective where it does not. Due to this fact it is very difficult to use this as an effective method. Commercially available UV cabinets are not effective enough at sterilizing all the surfaces of masks which are concealed from the light although there may be specially designed cabinets in time with proven efficacy.

8. Cleaning / Disinfection Equipment and Cleaning Methodology

Once appropriate cleaning chemicals, disinfection chemicals, and processing equipment are selected, a methodology can be developed which works for the volume of equipment, type of contamination, required turnaround time etc.

Traditionally, masks are immersed in disinfectants/ cleaners with varying degrees of stripping down, drying, rebuilding, and testing. Whilst these methods are acceptable, they are very labour intensive, which is where cleaning machines are useful. For heavily soiled equipment, there may still be no substitute to cleaning by hand but having the right cleaners and brush ware will make the manual process efficient as possible.

A typical Manual Process for Masks

1. Masks are immersed in a cleaning solution, then removed and rinsed.
2. Masks are then immersed in a disinfectant solution then removed and rinsed.
3. Masks are then air dried.

For typical soiling, such as dirt, oils and grease a good processing method could consist of the following 6 stages:

Stage 1 – Assessment and segregation

Masks are assessed for soiling and appropriately, split into the following:

a. Severe - Masks which have a lot of soiling and require strip down.
b. Medium - Masks which have soiling but will not require strip down to clean effectively.
c. Light – Masks which have little or no visual soiling

Stage 2 – Cleaning

Masks are stripped down first if severely soiled before cleaning. During this phase brushes and microfibre cloths can be used and colour coding of these is recommended so there is not 'cross- contamination' between masks

Stage 3 – Disinfecting

It is not possible to effectively disinfect a mask which is heavily soiled. Some masks which do not have visible soiling could pass straight to the disinfection stage.

Stage 4 – Drying.

The masks then require drying using cloths manually or a drying cabinet.

Stage 5 – Testing and inspection

This should be performed according to the manufacturer's requirements.

Stage 6 – Packaging

The final stage in the process is packaging ready for re-use. This can include bagging / boxing etc. Heat seal bagging will give user confidence that the mask is freshly processed, and no one has worn the mask before.

Facility layout

Laying out a facility which has lean principles such as 5S applied, will ensure that the chemicals, equipment, and methods are optimised.

9. Manage and review programme.

Regular review of the effectiveness of the programme will ensure fine tuning and management of change. A system which is approved with a variety of manufacturers equipment will ensure seamless transitions in the event of changes of R.P.E.

Glossary

Cleaning - removal of soiling to equipment

Disinfection – the process of destruction or inhibition of disease-producing microbial growth. Different processes can be used to disinfect a product, including heat, steam, chemicals, and ultraviolet light.

Sterilization – destruction of microorganisms under controlled conditions.

Scope and disclaimer: The scope of this report covers how to address specifically the cleaning and disinfection processes relating to respiratory protective equipment. Thorough information on the testing of the equipment is not provided as this will need to comply with manufacturers specific requirements and national or regional legislation. Methods and equipment described in this report are intended to provide a balanced resource, there is no guarantee that this is fully comprehensive.

Bibliography:

General Disinfection Guidelines, (Whitepaper) R.F. Khars, 1995

Respiroclenz 2020, Available: http//www.respiroclenz.com

Benchmark Guidance Values for Microbiological Monitoring on Surfaces: A Literature Overview, (Report) March 2018, R. Giovinazzo, L. Caradonna and others of Technical Advisory Sept for Risk Assessment and Prevention, Italy.

Cleaning and Disinfecting 3M Scott Reusable Full Face Respirators Following Potential Exposure to Coronaviruses, (Tech Bulletin) April 2020 r.3

Microbiological Aspects of Cleaning Validation (PowerPoint) Dr T. Sandle