COVID-19 and Chemical Engineers

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Section 1 What is a Major Hazard?

COVID, COSHH and Process Safety.

Traditional Major Hazard

- The IChemE's billing for this conference opens with the following statement
  - Hazards is widely recognised as one of the world's leading process safety conferences. First staged in 1960, Hazards is an industry-focused event, providing a platform for sharing good practice, current thinking and lessons learned in process safety, as well as valuable networking opportunities.
- Based on the above major hazards are connected to process safety but the COVID-19 pandemic has shown us that this definition is too narrow and the definition should be far broader.

Major Hazards and Seveso III

- Certainly, those hazards covered by the Seveso III Directive (COMAH in the UK), for example are major hazards relevant to chemical engineers.
- The 1984 incident at the Union Carbide pesticide plant in Bhopal, India, released at least 30 tons of a highly toxic gas called methyl isocyanate killed more than 3,000 (possibly as high as 15,000 people) and injured over 500,000 people. This was clearly a major hazard relevant to chemical engineers.

But what about major diseases?

- As we discuss later on diseases kill millions of people per annum.
- Arguably all of these are preventable deaths.
- COVID-19 at 4.5 m and rising is currently the number 3 largest killer.
- Even diseases such as flu and pneumonia combined have killed more than 60,000 people in a year just in the UK e.g 1976 and 1999.

https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsduetocoronaviruscovid19comparedwithdeathsfrominfluenzaandpneumoniaenglandandwales/deathsoccurringbetween1januaryand31august2020

Major diseases are Major Hazards

- Clearly major diseases cause considerably more deaths than industrial accidents and deserve the full attention of chemical engineers.

Medical professional not chemical engineers

- It could be argued that major diseases are the realm of medical professions and not chemical engineers.
- True, they are the front line of the fight against disease but without the products and services provided by chemical engineers they simply could not function.
- No hospitals, no medicines, no medical devices and no surgical instruments etc.

COVID-19 and COSHH

- The phrase “biological agent” is defined by reference to regulation 2 of the COSHH 2002 and includes any micro-organism which may cause infection. This is broad enough to include Covid-19.
- Under COSHH employers owe a duty of care to their employees and third parties.
- Employer’s duties include carrying out a risk assessment and adequately controlling exposure to COVID-19.

COVID-19 and RIDDOR

- HSE guidance states (https://www.hse.gov.uk/coronavirus/riddor/index.htm)
  - You should only make a report under RIDDOR when one of the following circumstances applies:
    - an accident or incident at work has, or could have, led to the release or escape of coronavirus (SARS-CoV-2). This must be reported as a dangerous occurrence
    - a person at work (a worker) has been diagnosed as having COVID-19 attributed to an occupational exposure to coronavirus. This must be reported as a case of disease
    - a worker dies as a result of occupational exposure to coronavirus. This must be reported as a work-related death due to exposure to a biological agent

COVID-19 and Process Safety

- There are many aspects of process safety that are relevant to protecting employees from COVID-19
  - Risk assessments
  - The Use of LOPA - as discussed later.
  - Containment, barrier technology and other engineering protection measures such as good ventilation
  - The correct use of PPE.

Section 2 Chemical Engineers and Major Diseases

Top 8 causes of death in 2019 (51%)

- Ischaemic heart disease 9 m
- Stroke 6.1 m
- Chronic obstructive pulmonary disease 3.3 m
- Lower respiratory infections 2.7 m
- Neonatal conditions 2.0 m
- Trachea, bronchus and lung cancer 1.9 m
- Dementias 1.8 m
- Diarrhoeal diseases 1.6 m

⇐ COVID -19 4 m and rising

World Health Organisation 2019 data

Involvement from Chemical Engineers

- Pharmaceuticals
- Food (+nutraceuticals)
- Water and sanitation
- Pollution minimisation
- Cleaning products
- Understanding of risk
- Safety systems
  - COSHH – containment, isolation, barrier technology, PPE including hard hats.

Practical Examples

- The COVID-19 pandemic has shown us many practical ways that chemical engineers can help to reduce the impact of major diseases.
- Section 3 shows the progress to date achieve by the IChemE/ISPE UK COVID-19 Response Team. A project team within the Learned Society space.

Section 3 IChemE/ISPE COVID Response Team – Progress to date

Volunteer Response

- IChemE & ISPE
- Volunteers from membership-supported by staff
- Other professionals
- International- UK, Sri Lanka, ROI, Australia, Malaysia
- Pharma & BE SIGs well represented
- Pandemic Viral spread and impact is clearly a biochemical system, generating serious hazards
- Room for other disciplines, beyond a medical problem

Project Approach

- As IChemE ISPE volunteers we can:
- Define the various problems relating to Covid
- Identify possible options to solve and appraise them
- Not indemnified to design and implement
- Implemention of projects requires cooperation with partners
- Our other role is knowledge sharing and making introductions

Initial Emergency Phase

- Oxygen distribution in hospitals due to increased demand-more patients needing oxygen, more oxygen demand by CPAPS masks
- Shared idea to enhance use of SS weldneck for oxygen distribution to enhance reticulation
- PPE materials one of our members sourced 0.1mm polycarbonate for visors

Barrier Technology

- Cooperation with an entrepreneur
- Perspex screen glove box technology
- Hierarchy of controls
- Cannot knowingly remove the virus
- Engineering solution next best
- Better than PPE
- Piloted in GP surgery in ROI

PPE Reuse VHP Sterilisation

- Breakout project-again collaboration
- Addresses shortages
- Potential for better PPE, personalised to user
- Less waste
- Less cost
- Was already adopted in USA for emergency use
- UK NHS did not adopt

Small Molecule Issues

- Small molecules taken by ingestion, synthetic
- Cost reduction tends to increase supply chain complexity and decrease security
- Shortages of everyday drugs due to increased demands, shipping costs increase
- Highly regulated, difficult to increase production
- Skill shortages-education & training
- UKRI/NIHR sponsored Oxford run RECOVERY trial-to identify existing drugs with Covid potential

Vaccine Issues

- Extremely sensitive to process conditions, ingredients etc.
- Replication of the Process difficult
- Quote-about 10,000 items of data are required in the production of a vaccine-all have to be satisfied
- Includes supply chain, fill finish, distribution, often cold chain

Technology Transfer Project

- Education & Training Gap
- A number of Volunteers have responded to the call to run a Technical Transfer Project
- Advanced knowledge and skills to assess items when they cannot be fully replicated in the new location

RAEng Collaboration

- RAEng is effectively the gateway to HM Gov for engineering-all disciplines
- Sir Patrick Valance request-Two of our volunteers contributed to the interim report “Infection Resilient Environments”
- Ventilation identified as a major topic
- Offer of LOPA tool for further work
- Infection encounter = initiating event
- ALAMA =risk of death if infected

International

- Sri Lanka, development of a mobile ICU
- Converted container, 3 beds, with CPAPS ventilators & patient monitors
- Airlock for entry/exit, monitoring station for nursing staff
- Air purification unit, containing UV-C, HEPA filters

Conclusions

- Pandemics (like COVID-19) are clearly major hazards to human life and health.
- Understanding the risks involved with a view to minimisation appears to fit within the province of the Process Safety Engineers, with some caveats.
- Access to authorities is key in order to allow Chemical Engineers to offer support e.g via the RAEng.
- Pandemics stress supply chains so that the provision of medicines and PPE should be regarded as a security and sustainability issue, and not just a cost issue.
- In the public domain there is a significant lack of understanding of the difficulties of vaccine manufacture.
- Understanding the nature of Pandemics as biochemical systems and liaison with other disciplines and specialists is clearly within the remit of chemical engineering.
- Public understanding of the relevant issues is low and perhaps IChemE has a role to play here.

Recommendations

- Chemical enginers should work more closely with RAEng to gain a better understanding of the conduits to HM Government.
- The weaknesses in the medicines supply chain highlighted by the pandemic should be included in IChemE's sustainability considerations.
- Further work should be done on the use of personalised high-quality PPE for health professionals, using VHP (or similar) to sterilise for reuse.
- A Technology Transfer project to assess the need for specialised advanced training to assess how to replicate manufacturing in another site should be started. (This is now in hand.)
- Understanding the nature of Pandemics as biochemical systems and the impact other specialists should be within the remit of chemical engineering.
- Providing concise educational material on these subjects – akin to writing operating instructions is within the province of the chemical engineer.