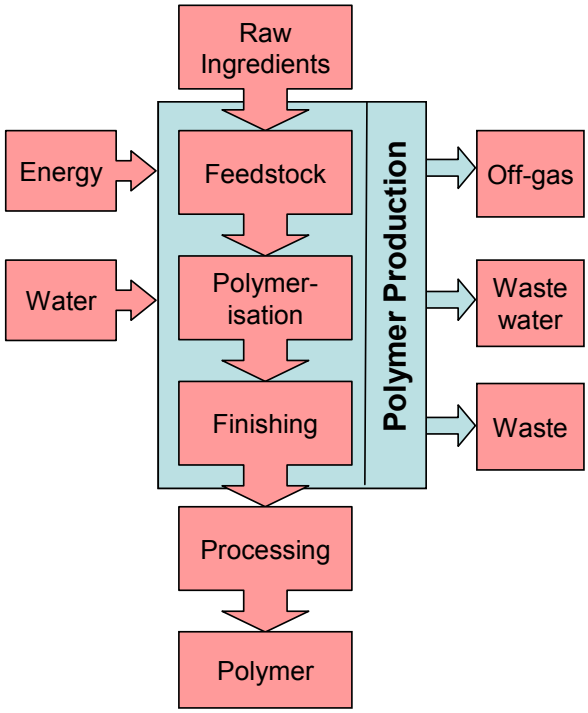
European Bank
for Reconstruction and Development

Sub-sectoral Environmental and Social Guidelines: Plastics and Synthetics

PROCESS DESCRIPTION

This guideline covers the manufacture of plastic and synthetic materials where monomers (see separate guideline on bulk organic chemical production) are polymerised and finished into pellets or granules for subsequent industrial use. It also covers the subsequent fabrication of plastic and other synthetic items as intermediate or finished goods.

The production of polymers requires high quality raw materials and chemicals. In general, batch processes are used when capacity is small and the product range is broad, whereas continuous processes are used for large-scale production of a small range of polymer grades. After polymerisation, the catalysts or initiators have to be destroyed and polymers separated from any residual monomers and the polymerisation medium. Finishing of the polymers may include addition of additives, drying, extrusion and pelletisation and packaging. Polymers are usually sold as powders, granules, sheets, or as liquid emulsions and solutions.



Source: European Commission 2006

There are two main types of plastic product fabrication processes:

- *Non-reactive* where the main raw material, the polymer, is supplied in the form of pellets or powder and combined with additives to give the required characteristics and then moulded, extruded or smeared into the intermediate or final product. They may also be dipped, diluted in solutions or in emulsions in the cases of coatings or additives. These are known as thermoplastics and can soften and melt reversibly when heated and harden when cooled. They can easily be recycled but this can degrade their properties. Typically, scrap and uncontaminated rejected parts from the process are granulated and mixed with virgin feed;

- *Reactive* where the liquid resins are combined with a catalyst and other fillers and additives to produce a thermoset plastic material. The material is moulded and allowed to cure. After curing, they harden permanently and decompose when subjected to high temperatures. They can not be recycled after use.

KEY ENVIRONMENTAL, HEALTH AND SAFETY RISK/LIABILITY ISSUES

Air Emissions

A large range of organic and inorganic chemicals may be released as raw materials or by-products of the production process.

- Volatile Organic Compounds (VOCs) emissions originate from:
  - drying and finishing operations in polymer plants;
  - compounding and forming operations;
  - process purges associated with the purification or raw materials, filling and emptying reactors and equipment and removal of reaction by-products;
  - fugitive emissions e.g. from leaking piping, valves, seals etc;
- Particulate matter emissions are associated with drying and packaging operations, pellet conveyance, transfer and dedusting; granulation and handling of dry additives;
- Heating of thermoplastics during compounding and forming may result in the release of fine aerosols;
- Venting and flaring may be adopted as safety measures to dispose of process gases in the event of emergency or other abnormal plant conditions. These discharges should be conveyed to blow-down tanks where the reactants can be recovered prior to discharge;
- Gaseous, liquid and solid waste incineration plants are frequently present at polymer manufacturing plants. Dioxins and furans could be generated. These are carcinogenic and can cause raised hormone levels giving rise to adverse reproductive and developmental effects, immune system abnormalities and heart related conditions. In high doses, they can cause severe skin disease (chloracne);
- Acid gases can be present in the exhaust air from polymer drying.

Air emissions are normally prescribed in permits which set emission limits to control releases for specific, named chemicals.

Energy Consumption

Polymerisation plants consume large quantities of energy and steam, which are typically produced on site in cogeneration facilities. In any combustion process, greenhouse gas emissions will be created.

Wastewater

Many facilities operate wastewater treatment plants to perform primary treatment to effluent prior to discharge to the sewerage system. However, in some cases, wastewater treatment plant may be a full mechanical and/or bio-treatment facility to treat effluent prior to discharge to surface waters, where no further treatment will be performed. Variations to

wastewater discharge consents may require changes in the operation of the treatment plant, in order to maintain compliance.

- Process water may contain a variety of hazardous substances and solids including: solvents, oils, surfactants, emulsifiers, acids, salts and heavy metals;

- Cooling and heating waters may be a source of thermal pollution.

Hazardous Materials

Significant hazardous properties relating to individual chemicals include flammability, combustion potential, toxicity, corrosive potential and oxidising potential. Chemicals with such properties should be labelled with the appropriate internationally recognised diamond shaped hazard symbol[1]. Inadequate control of hazardous chemicals can elevate the risk of major accident harming workers, the local community and the environment.

Some chemicals may only possess a hazard potential if they have the opportunity to react with other compounds. Chemicals with different hazard symbols should not be stored together - clear guidance on the compatibility of different chemicals can be found in the Materials Safety Data Sheet (MSDS) which should be readily available from the manufacturer and available on site.

Accidental release of hazardous chemicals on site and in transit may result in explosions, air pollution and significant environmental impacts in relation to soil, groundwater and surface water contamination. Releases of hazardous substances to the air could impact the local environment including human receptors.

Hazardous Wastes

Depending on the chemical processes carried out varying quantities of hazardous waste will be produced, including spent catalysts which can contain nickel, platinum, palladium and copper depending on the process; saturated filtering beds; solid polymer wastes; acids and solvents; and biologically active chemicals. The disposal of hazardous wastes requires that adequate measures be taken to identify the waste and adopt the most appropriate route for disposal at the final disposal facility. Strategies for managing these wastes include: minimisation, proper containment during temporary storage and transport, and off-site management by licensed, specialised companies.

Permitting

Plastics and synthetics processes in the EU are subject to national regulations under the Integrated Pollution Prevention and Control Directive (2008/1/EC) and the Seveso II (1996/82/EC) which aims to control the major accident hazard from dangerous substances. Operations outside the EU will still be subject to local regulation.

Legal entities in the EU manufacturing, importing or using certain chemical substances may be subject to a new EU regulation called the Registration, Evaluation and Authorisation of Chemicals (REACH) (1907/2006). This regulation places potentially new requirements on "users/manufacturers" to evaluate and control the health and environmental risks associated with certain substances.

[1] United Nations 2007

OTHER ENVIRONMENTAL, HEALTH AND SAFETY RISK/LIABILITY ISSUES

Noise

The physical processing of polymers, e.g. screening, grinding, pneumatic conveying as well as compressors and other machinery, steam relief valves, large combustion units and flares can generate high noise levels that can lead to noise induced hearing loss.

Soil, Groundwater and Surface Water Contamination

Contamination of soil, groundwater and surface waters (on site and in transit) can occur through incidents and accidents such as a major spillage or via gradual or repeated leakage. Surface waters are particularly vulnerable to chemical contamination. Chronic, undetected leakages on site can occur as a result of fractured vessels, seals, valves and pipelines.

Confined Spaces

Storage silos are dangerous confined spaces and entry to them must be strictly controlled and avoided wherever possible.

Fire/Explosion risk

The main concern for safety is the control of the reaction temperature and of oxygen due to the exothermic nature of the process and the resulting danger of a reaction that goes out of control.

Major explosions or fires at chemical storage facilities have resulted in widespread contamination and destruction, impacting not only the immediate site but surrounding land, rivers and communities. The release of hazardous gases which may travel many kilometres from the site, is of particular concern. Compensation costs for such incidents are high and widespread remediation and rebuilding may be necessary.

- Fires can generate black acrid smoke and poisonous gases including carbon monoxide. These fires can spread quickly and be difficult to extinguish;
- Granulators produce a fine polymeric dust that can explode if suspended in air in high concentrations;
- Pentane, an extremely flammable gas, can be released during the storage and transportation of expandable polystyrene bead and from finished products shortly after manufacture;
- Some chemicals have low ignition points and can spontaneously ignite if incorrectly stored and handled.

Chemical Exposure

- Some resin formulations contain hazardous materials e.g. aromatic amines, that present a skin exposure hazard and can penetrate the more commonly used protective gloves;
- Some isocyanates represent a significant respiratory and skin hazard.

Security

Chemical plants, storage and distribution networks could be targets for criminal or terrorist attack and therefore appropriate security measures must be implemented to minimise this hazard.

Polychlorinated Biphenyls (PCBs) and Asbestos

- PCBs are a group of substances which are good electrical insulators. Typically, PCBs may be present as constituents of hydraulic oils or dielectric fluids in electrical switchgear, transformers and fluorescent light starters;

- Asbestos has been used on a large scale for many years as a fire proofing and insulation material and may be encountered in a wide range of forms including asbestos cement boards, as fire retardant gaskets in pipework and as fire retardant insulation around boilers and furnaces.

Particular attention should be given to buildings constructed before the 1980s.

KEY SOCIAL, LABOUR AND COMMUNITY RISK/LIABILITY ISSUES

Public Anxiety

Public anxiety, particularly from residents neighbouring a site, can be caused by a lack of knowledge regarding the nature of the chemicals being stored on the site, odours from the site, the potential for fires and explosions and the action that will be taken in the case of an accidental release. This public anxiety can result in significant planning constraints being imposed on this type of facility.

Dust and Odour

- Public/environmental health and nuisance issues associated with dust and vented fumes can arise from production activities and may have a significant effect on neighbouring locations.

- Many of the substances produced or used have the potential to create an offensive odour to neighbouring communities. This arises from the handling of malodorous substances and fugitive releases of organic solvents.

Transport

Transport of products by either road can be a significant issue. This might lead to road noise and traffic congestion.

FINANCIAL IMPLICATIONS

- Many countries are signatories to the Kyoto Protocol and have adopted targets for the reduction of CO_2 emissions. Where Governments have set up carbon emission reduction programmes industrial processes have been required to reduce their CO_2 emissions through the setting of targets. This can result in a need for substantial investment in new/clean technologies to achieve the emission targets. These targets may be reflected in environmental permits.;

- Under the EU Emissions Trading Scheme (ETS) Member States allocate allowances for carbon emissions to industrial sites, including refineries. The scheme can create both financial assets or liabilities and entities can trade their carbon allowances;

- Injuries may lead to increased payroll costs to replace skilled workers and lost production time;

- Capital investment may be required to comply with new environmental, health and safety requirements;
- There is a relatively high potential for soil and groundwater contamination to be present which can be very costly to remediate;
- Fines, penalties and third party claims may be incurred for non-compliance with environment, health and safety regulations;
- If the products are manufactured, sold or used within the EU they must be registered under the REACH regulations. This may represent a substantial cost and will be particularly significant to manufactures producing small quantities of a large range of chemicals.

IMPROVEMENTS

Environmental, Health and Safety Improvements

- Conduct a facility wide risk assessment, including detailed consequence analysis for events with a likelihood above 10^{4}/year;
- Aim to minimise fugitive releases of liquid and gaseous organics at the design stage by the specification of high quality items and materials of construction which minimise leakage;
- Implement a formal Leak Detection and Repair (LDAR) programme and where necessary, replace with higher quality items, any equipment which generate significant fugitive emissions;
- Regular inspection should be carried out of all bulk containment and infrastructure on site to prevent leakage and product loss;
- Provision of secondary spill containment for bulk storage tanks and silos;
- Install automated filling systems for tanks and drums to minimise spills;
- Recover and re-use raw materials and waste plastic where practicable
- Source segregation and pre-treat concentrated wastewater streams;
- Good housekeeping should be maintained at all times in all areas;
- Installation or upgrade of abatement technology to minimise exposure to toxic raw materials and products and to control the release of volatile or dust emissions, e.g. enclosure of equipment, appropriate ventilation with filters, gas balancing systems;
- Enclose conveyors and storage areas to reduce dust;
- Maintain on site abatement equipment and treatment plant;
- Recycle wastewater where possible;
- Remove VOCs from wastewater by flash distillation or equivalent prior to treatment at wastewater facility;
- Upgrade wastewater treatment facilities as appropriate to the plastics produced, enable segregation of difficult waste streams for separate treatment e.g.

- Separate and recycle organics into the process or incinerate;
- Catalytically or thermally incinerate non-recyclable contaminated streams;
- Neutralise acidic and caustic effluents;
- Collect oily effluents in closed drains;
- Containment and treatment of VOCs;
- Membrane filtration or other physical/chemical treatment for metals removal;
- Activated carbon or advanced chemical oxidation for organics and non-biodegradable COD;
- Reduction in toxicity using appropriate technology;
- Containment and neutralisation of nuisance odours.

- Emergency storage lagoons may be needed to prevent contaminated firewater reaching controlled waters;
- Provision of personal protective equipment (PPE) that is fit for the task to prevent injury and maintain hygiene standards. Staff should be trained in the correct selection, use and maintenance of PPE;
- Train workers in correct use of machinery and safety devices;
- Separation of people from moving equipment:
  - Ensure that the process layout reduces opportunities for process activities to cross paths;
  - Installation of safeguards on moving parts of conveyor belts to reduce risk of entrapment of employees;
  - Install walkways to separate people from vehicle movements to reduce risk of collision;
- To reduce the risk of noise exposure isolate noisy equipment and rotate tasks to minimise time spent in a noisy area over an eight hour period and provide personal protective equipment where people have to enter noisy areas;
- Route cables and pipework under walkways to prevent slips, trips and falls;
- Construct walkways of non slip materials;
- Install automatic alarms and shut off systems;
- Install redundant safety systems to cater for the risk of pipe-plugging by polymer formulation with pressure safety valves. Systems should be subject to frequent and proper inspection;
- Maintain an up-to-date inventory of all substances present or likely to be present which could be hazardous to health or the environment;
- Maintain Material Safety Data Sheets (MSDS's) on site
- Provide local fire department with list of products stored on the premises;

- Control the effect of fires and explosions by segregating process, storage, utility and safe areas;
- Avoid potential sources of ignition including banning smoking in and around facilities;
- Use explosion-proof equipment and conductive materials and ensure that equipment is grounded and bonded;
- Consider the need for upgrades to security measures.

Social, Labour and Community Improvements

- Implement a programme of assessment of routine monitoring of worker health;
- Involve the neighbouring community in the creation and practice of plans to respond to major incidents at the installation.

GUIDE TO INITIAL DUE DILIGENCE SITE VISITS

During the initial site visit, the issues will vary according to the type of product being produced and depending on the level of environment, health and safety management already introduced. While visiting the site it is important to discuss and review the following:

- Confirm organisational responsibilities and systems for EHS.
- Check the condition of the wastewater treatment plant and location of discharge points for wastewater from the facility. Note the colour and appearance of adjacent watercourses;
- Note whether the wastewater treatment plant discharges to a local watercourse or the municipal wastewater treatment works. Higher environmental risks will be associated with facilities discharging to water courses;
- Check the condition of storage facilities for raw materials and finished products;
- Note any odours that might cause a nuisance;
- Note the noise and dust levels at the site to determine whether abatement equipment is in use or might be required;
- What is the standard of "housekeeping" on site? Do areas look clean and tidy? Look for evidence of any recent spills or releases of raw materials/product;
- Are staff wearing Personal Protective Equipment?
- Check signage around the site:
    - Does it convey the health and safety risks?
    - Are fire exits and/or evacuation routes clearly marked?
    - Are there demarcated routes for pedestrians and vehicles?
- Is fire fighting and first aid equipment available? Is there trained and competent fire fighting resource on site?
- Check the age and condition of equipment, look for signs of wear and tear, degradation, leaks and breaks;

- Check that solid waste storage and disposal (storage equipment) is in a good condition;
- Check that waste storage areas are clear of debris and that skips are covered to prevent waste escaping, for example, check that waste containers have lids or are stored in an area with a roof;
- Have the premises been inspected recently by the regulatory authorities for health, hygiene and environment? What were their findings?
- Check for automatic safeguards on machinery to prevent accidental injury;
- Check that wages and working hours are consistent with the average for the sector and national standards;
- Does the organisation have insurance in place to cover the recall of contaminated/faulty products? Have there been any recent product recall incidents?
- Does the organisation have insurance to cover any significant damage to the environment/community/operations (this may be covered by public liability insurance or the organisation may be party to an industry insurance scheme). Review the terms of the cover.
- Has the organisation been subject to environment and safety or quality audits by customers/insurers? What was the outcome of these audits?
- Have there been any recent incidents on site such as fatalities, fires/explosions, spills? Is insurance in place to cover such incidents?
- Does the business plan have line items for Environment, Health and Safety improvements as well as asset management and maintenance?
- If investment or refinancing will lead to restructuring of the organisation what will be the potential impacts on health and safety at the operation and wider community? Have these been considered and assessed by the company?
- If the company plans to invest in new technology, what will be the impacts and benefits for human resources??
- Check the conditions and duration of validity for all permits.

Social, Labour and Community

- Check that labour standards, contracting and remuneration are in line with national law and are consistent with the average for the sector;
- Check that hours worked, including overtime, are recorded and staff should receive written details of hours worked and payment received;
- Check that wages and working hours are consistent with the average for the sector and national standards;
- Has the Company received inspections from the local labour inspectorate in the previous three years? Have these resulted in any penalties, fines, major recommendations or corrective action plans?

- Does the organisation have a grievance mechanism which allows employees to raise workplace concerns?

- Are employees free to form, or join, a worker's organisation of their choosing?

Take note/ask questions relating to any activities that address the improvements listed in the improvements section of this document.

ACTION PLANS

Dependent on the individual business, select appropriate improvements from the list above to include in the action plan. As a minimum, any business should be required to have the following in place:

Environmental, Health and Safety

- Operational procedures to manage environmental, health, safety and social risks;

- Monitoring programmes;

- Improvement objectives, targets and project plans;

- Training for personnel;

- Regular inspections, checks and audits with records to demonstrate achievement of the required level of performance against legal requirements and improvement action;

- Emergency plans for environment, health and safety accidents or hygiene non-compliance;

- Management review/demonstrated involvement in environment, health, safety and hygiene management.

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