Compliance Assessment Report CAR_NRW0039164

Permit being assessed: PP3238LX.
For: Barry Thermosets Plant EA/EPR/PP3238LX/V002, held by Hexion UK Limited
At: Barry Thermosets Plant Sully Moors Road , Penarth, Vale of Glamorgan, CF64 5YU.

Type of assessment carried out: Audit, Reason: Routine.
On 13/01/2022.
Parts of permit assessed: BAT Assessment For Chemical Production

NRW Lead Officer: Andi Kemp.
Report sent to: Ian Beatty, EHS Manager on 13/01/2022.

1. Summary of our findings (full details in section 4)

Part of permitted activity assessed (criteria)	Assessment result	Permit condition
A1 - Specified by permit	Assessed (A)	
B1 - Infrastructure - Engineering for prevention and control of emissions	Assessed (A)	
B5 - Infrastructure - Plant and equipment	Assessed (A)	
C2 - General Management - Management system and operating procedures	Assessed (A)	

Result types are explained in more detail in the 'Important Information' section below.

Total number of non-compliances recorded	Total non-compliance score
0	0

How we use the non-compliance score to calculate your annual fee is explained in the 'Important Information' section below.

2. What action is required?

No action required.

3. What will happen next?

Any non-compliance we have identified and recorded on this form is an offence. It can result in criminal prosecution and/or suspension or revocation of your permit.

At this time, we do not intend to take any further action.

This statement does not stop us from taking additional enforcement action if further relevant information comes to light or offences continue.

4. Details of our assessment

Compliance Assessment Report: Bakerlite (formerly Hexion) PP3238LX January 2022

Purpose Of Compliance Assessment

This compliance assessment report covers a remote inspection assessing the chemical production of resole phenol – formaldehyde resins in terms of Best Available Technology (BAT). Relevant permit conditions are: 1.1.1 – General management; 1.3.1 – Energy efficiency; 1.4.1 – Efficient use of raw materials; 1.5.1 – Avoidance, recovery and disposal of wastes; 2.1.1 – Permitted activities; 2.3.1 – Operating techniques. This site is permitted as a Section 4.1 Part A(1)(a)(viii) Schedule 1 Environmental Permitting Regulations installation, producing polymers – various grades of phenolic resins. Relevant guidance covering BAT is the BAT Reference Document (BREF) for polymers (2007), but reference can also be made to the BREF for Fine Organics and the associated EA / NRW Sector Guidance Notes for Fine / Speciality Organics, in addition to the generic How To Comply With Your Environmental Permit.

The scope of the audit covers the production of the resole resins. Raw material storage and final product storage is not covered, nor is maintenance and emergency response. Aspects such as production chemistry and conditions, recovery of distillates, pressure relief, exotherm control are covered, as is product development, approval and changes.

Documents Referred To

- Hexion Inc. Phenol – Formaldehyde Resin Safety Standard 21st May 2018
- Hexion Product Development Process Issue 3
- Hexion Product Approval Process Issue 10
- Resole Chemistry page showing “curly arrow” reaction mechanisms
- Hexion PF Resin Serious Incidents Review
- NRW BAT For Production Audit Pro – forma – completed by Hexion
- BAT Reference documents: polymers (2007), speciality organics (2006)
- EPR Sector Guidance Notes and / or NRW Additional How To Comply guidance notes
- Hexion original permit application (USR FR551 March 2006)
- EA permit issue decision document

Review Of Original IPPC Application and Permitting Decision Document

The products produced at the installation are bespoke variations on resole phenol – formaldehyde resin recipes, depending on customer requirements and end use. The production is carried out in one of several (several reactors may be running on different orders) batch reactors run on a semi-continuous basis with heat released, which is dealt with by cooling reflux in an overhead condenser. No gas is evolved, but vapours are routed through the scrubbing system and the reactions are carried out under vacuum. Bursting discs are fitted and discharge to a deluge tank.

Small high intensity reactors (at the time of the application as stated in the application, pg. 18), which are generally considered BAT, do not exist for resole production. In terms of yield, the figures quoted are around 97%, which is a high figure. Hexion, at the time, committed to continuously investigate ways to reduce waste. Distillate is discharged to the effluent treatment system, vapours are scrubbed and other

effluent is produced from reactor wash outs, unreacted materials and vacuum seal water purges.

There is also a phenol recovery unit, with recovery rates quoted (2006) as 95% phenol recovered from distillate. It was stated that this unit was associated with the decommissioned Novalacs process and hence no longer operates.

The process control is either fully automated or semi-automated and controlled and overseen by control room operatives and plant operators. The charging of formaldehyde needs to be controlled to prevent runaway. After the P-F reaction, additives may be added. Safety interlocks and trips exist, e.g. temperature (associated with steam evolution) leading to high pressure situations, which trip to stop raw material charging and invoke the deluge system to quench the reaction.

A target was set for the end of 2006 to reduce distillate disposal to 65 t per month. Raw material usage is dictated by customer requirements and resole chemistry and as stated yields are high. Water is used for resin production along with electricity and gas for steam raising.

Overall it was stated throughout the application that the installation generally met BAT. The EA (at the time) decision document records the following points related to BAT demonstration:

- Satisfied with operator competence
- Appropriate management system in place (ISO 14001 certified)
- Prevention and response to operating condition excursions and accidents in place (Upper Tier COMAH site)
- Efficient use of raw materials, energy and water
- Improvement Programme (IP) IC8 and IC9 put into permit relating to origins and nature of waste produced, including resins and investigation of reduction of these wastes
- IP item IC3 for assessment of emissions to air, including reactor scrubber point A2
- Emission limits tightened for A2 formaldehyde and at sector benchmarks, including phenol, with typical concentrations significantly less than limits, i.e. scrubber abatement considered BAT and limits indicative of BAT

Key Criteria To Establish Best Available Technology (BAT)

Referring to sector guidance notes, How To Comply and BAT Reference documents (BREFs), below are the main points relating to BAT for chemical production:

- Batch continuously stirred reactors are typically used in this process and due to high yield (97%) and reaction specificity, using these reactors as opposed to small high intensity reactors does not present a deviation from BAT at present
- Raw material and energy efficiencies must be demonstrated and waste reduced – this had at the time of the application been partially demonstrated, with additional work to look at waste resins (amongst other waste) – now covered in the EMS audit schedule, performance targets and annual submissions
- Reducing emitted substances (phenol, formaldehyde) to effluent
- Climate Change Agreement entered into
- Establishing performance indicators
- COMAH will cover major accidents, so lesser events (spills from IBCs etc.) should be managed in addition by the permit
- Using less harmful raw materials – mainly dictated by the well established resole chemistry and

customer requirements, but investigations should be carried out periodically and new technology explored and assessed
- Good reaction specificity and yield therefore minimal downstream separation processes required
- Reactor cooling is not by water and disposal, but by overhead condensation and reflux
- Environmental issues addressed when making plant modifications or new processes – use of HAZOP
- Effluent equalisation, recirculation and calamity capacity
- Appropriate control of pressure, temperature, pressure relief, quenching, charging, stirring, dump tanks
- Design, installation and maintenance of vessels, pipework, valves, pumps and flanges to identify and prevent leaks from corrosion, damage etc.
- Avoiding / reducing emissions to air during purges and reactor clean outs
- Well established and understood reactions and consideration of small high intensity continuous reactors as technology develops
- Highest reaction yields as possible
- Minimising liquid effluent from wash outs by applying: limiting internal baffles and coils; minimising surface area; flush via bottom outlet on vessels; piping to slope to reactor drain points; campaigns sequenced to minimise wash outs; distillation for optimum liquid vapour separation
- Implementing an EMS
- Efficient and safe process control for start-up, operation and shutdown
- Identify key performance indicators
- Rework, reuse of recovered materials
- Fully assessing process safety
- Understanding process mass balances
- Adequate training of operators

These points should provide a useful quick reference for things to be considered to maintain BAT.

Audit

The main evidence gathered from the audit and assessed here is from the audit proforma sent to the operator and discussed before they filled it in – this completed proforma is appended to the audit and asks a number of questions covering aspects of chemical production. Also used as evidence are the Hexion P-F Resin Safety Standard; Product Development Process; Product Approval Process; Resole Chemistry figures; and P-F Resin Serious Incidents – a review document.

Many, if not all, of the points mentioned above as contributing to BAT, should be able to be addressed in the audit evidence bundle. Where relevant, actions or recommendations will be made by the regulator. The main point in this audit is to cover BAT demonstration, without overlapping too much with COMAH aspects – some overlap is inevitable as the BREFs state process safety, risk assessment, design and maintenance practices etc., are considered BAT.

Hexion (now Bakerlite UK Ltd.) have a long history of developing, manufacturing and leading on process safety for P-F resins. The Safety Standard outlines the approval process to deviate from the standard, while still retaining an equivalent documented basis for safety. The standard describes the chemistry and its hazards: exothermic, first order reaction rate (rate doubles with doubling of reactant concentrations) and also doubles with every 10 deg. C increase, prevent runaway and pressure excursions. The safe charging of phenol, catalyst and water first, then the controlled addition of formaldehyde with temperatures closely monitored and controlled. This controlled addition of formaldehyde over 30 minutes ensures the cooling

system can remove the heat efficiently enough to prevent runaway. Water quench to stop the resole reaction is also utilised. There are rupture discs and an associated sizing process.

The Safety Standard goes on to cover key deviations, such as inadvertent bulk charge, ingredients added in the wrong order or formaldehyde added too fast or first, insufficient reactor agitation, incorrect temperature (leading slow reaction and formaldehyde build up). Failure to remove heat is also a critical deviation to be avoided.

The equipment design and build standards are referenced, e.g. local pressure vessel standards or ASME Section VIII – Rules For Construction Of Pressure Vessels. Compatibility of materials of construction with raw materials and the process conditions are considered as is the requirement for resole reactors to be able to strip or distil water from a deluged batch. Pressure relief options and design ratings are sized by using a calculation that ensures the relief area will limit pressure build up to less that 10% overpressure. Reactor agitator design and power requirement is based on reactor volume. In terms of cooling the Safety Standard requires as a minimum an overhead condenser and vacuum pump system – as it at the Barry Thermosets plant. If power fails, back up power will run the instrumentation, agitators and deluge water to reactor. A variety of monitoring and process control sensors have been described, for example, reactor temperature, reflux return, cooling water flow, agitator power, limit switches on phenol and formaldehyde charge valves. These form part of a Safety Instrumented System, whose reliability is defined by fault tree analysis and appropriate SIL rated equipment, with independent controls. Interlocks prevent the reactants charging at defined different temperatures.

Certain aspects of the process are inspected and tested regularly, e.g. deluge water flow, back up power, rupture discs, raw material scale calibration, reactor visual inspection (including internal), agitators, calibration of temperature and pressure sensors, raw material flow meters, interlock alarms.

Approval of resole product formulas go through a structured process involving several key personnel. The Safety Standard is “owned” by a member of staff, supported by a P – F Technical Committee. The Standard has to be approved by the Approval Board and revalidated every 5 years.

Product development is jointly carried out to the Quality System Operating Manual Product Development Process, by an R&D facility in Germany and at Barry. A flow chart describes the process. This could be triggered by a customer enquiry, followed by project entered onto the project management system, formulation developed, customer validation and feedback.

Product Approval also follows a set management system procedure and typically involves development chemists, the Product Information Group (owner of this process), Quality Assurance and manufacturing. The whole process is supported by a number of other company procedures such as technical, QA, plant, engineering and regulatory approvals and the end formulation is subject to testing.

The Resole Chemistry sheet clearly shows the reaction materials and mechanisms and from this the reactor type (batch recipes), raw materials and reactor conditions are all derived. This means that employing continuous high intensity reactors may be difficult, based on the reaction charging and chemistry, plus the numerous product recipes and changeovers.

Another aspect that is certainly covered by COMAH, but is also BAT under EPR is accident management. To support Hexion’s approach here the company has evaluated the reasons and consequences of several P – F resin incidents from around the world from 1965 – 1997. From this document lessons have been learned and changes made to things such as relief sizing, automatic formaldehyde dosing, temperature control, avoiding control system bypass, ensuring reactors are empty before each new batch.

Considering all this evidence key BAT demonstrations have been made. The chemistry and customer

requirements define the raw materials and production conditions. Heat being given off cannot be recovered, it is removed by condensation and reflux. Emissions to air are reduced (currently significantly below the permit limits) by a common scrubber. Clean outs are restricted to just between batches of incompatible recipes. Phenol is partially recovered and reworked along with caustic soda from cleaning. Amongst other performance indicators, the amount of phenol in distillate is calculated. Reaction yield is good with little if any side reaction products and waste. Design codes and standards are followed, along with generic best practice. SIL rated interlocks are employed on critical items, such as formaldehyde charge and water deluge flow. The EMS and QMS control maintenance regimes, data and process variable recording, operator training. Appropriate calculations or programs are used for pressure relief sizing, water deluge system requirements, SIL rated equipment. Back up power will run critical equipment and the plant can be shut down safely, with strict order of precedence for start-up actions.

A recent (last 5 years) ESOS energy efficiency review found no major energy saving opportunities

Recommendations

1. Operator to consider other substitute raw materials that could produce products that match quality and performance and environmental standards of customers.
2. Operator to explore options for continuous, high intensity reactors.
3. Operator to continue the drive to reduce phenol and formaldehyde in the effluent.
4. Operator to ensure changes (MoC, new products, processes etc.) include environmental and sustainability (including fate of wastes) criteria.

END

If you have any queries about this report, or to discuss completion of any actions, please contact the NRW Officer named above.

Important information

Legal status of this report

Your permit is issued to you under the Environmental Permitting Regulations. You have a responsibility to comply with the conditions of your permit and prevent pollution/harm of the environment. You must also ensure that you comply with any other relevant legislation that may apply to your site's operations.

This report explains the findings of our assessment and any action you are required to take. We categorise non-compliance using our guidance for assessing non-compliance at regulated sites.

When we find potential non-compliance/s we will normally give you advice on how to maintain compliance.

To correct non-compliance, we may:

- require you to take specific actions
- issue a notice
- review the conditions of your permit.

Any advice and guidance we give will be without prejudice to any other enforcement response that we consider may be required.

Assessment results and non-compliance categories (used in section 1):

Assessment result	Description
Assessed (A)	Assessed or assessed in part, no evidence of non-compliance found
Action only (X)	Action only relating to the activity assessment
Ongoing (O)	Ongoing non-compliance, not scored

Non-compliance category	Description	Score
C1 Major	Potential to have a major, serious, persistent and/or extensive impact or effect on the environment, people and/or property	60
C2 Significant	Potential to have a significant impact or effect on the environment, people and/or property	31
C3 Minor	Potential to have a minor or minimal impact or effect on the environment, people and/or property	4
C4 No environmental impact	Non-compliance at a regulated site that cannot foreseeably have any impact on the environment, people and/or property	0.1

How we use assessment scores

The number and severity of non-compliances recorded in a year will affect your annual subsistence fee the following year. A non-compliance factor is added to your site's Operator

Performance Risk Appraisal (OPRA) score when we calculate your fee to reflect the additional resource we use to assess permit compliance.

What are suspended scores?
In line with our guidance, we may suspend scores for up to six months to allow time for remedial action to be taken. Suspended scores will be re-instated if the action is not completed.

Full list of Industry and Waste action criteria (used in section 1 and 2):

A: Permitted activities
- A1 Specified by permit

B: Infrastructure
- B1 Infrastructure – Engineering for prevention and control of emissions
- B2 Infrastructure – Closure and decommissioning
- B3 Infrastructure – Site drainage engineering (clean and foul)
- B4 Infrastructure – Containment of stored materials
- B5 Infrastructure – Plant and equipment

C: General management
- C1 General management – Staff competency/training
- C2 General management – Management system and operating procedures
- C3 General management – Materials acceptance
- C4 General management – Storage, handling, labelling and segregation

D: Incident management
- D1 Incident management – Site security
- D2 Incident management – Accidents, emergency and incident planning

E: Emissions
- E1 Emissions – Air
- E2 Emissions – Land and groundwater
- E3 Emissions – Surface water
- E4 Emissions – Sewer
- E5 Emissions – Waste

F: Amenity
- F1 Amenity – Odour
- F2 Amenity – Noise
- F3 Amenity – Dust/fibres/particulates and litter
- F4 Amenity – Pests/birds and scavengers
- F5 Amenity – Deposits on road

G: Monitoring and records, maintenance and reporting
- G1 Monitoring and records, maintenance and reporting – Monitoring of emissions and environment
- G2 Monitoring and records, maintenance and reporting – Records of activity, site diary/journal/events
- G3 Monitoring and records, maintenance and reporting – Maintenance records
- G4 Monitoring and records, maintenance and reporting – Reporting and notification to Natural Resources Wales

H: Resources efficiency
- H1 Resource efficiency – Efficient use of raw materials
- H2 Resource efficiency – Energy efficiency

Enforcement response
Any permit condition non-compliance is an offence and we may take legal action against you. Action we take can include prosecution, serving a notice on you and/or suspension or revocation of your permit. See our Enforcement and Sanctions Guidance for further information.

Data protection notice
You should make sure that anyone named in this report knows that the information it contains will be processed by Natural Resources Wales to fulfil its regulatory and monitoring functions and to maintain the relevant public register(s).

We may also use and/or disclose the report in connection with:

- offering or providing you with our literature or services relating to environmental matters
- consulting with the public, public bodies and other organisations (e.g. Health and Safety Executive, local authorities) on environmental issues
- carrying out statistical analysis, research and development on environmental issues
- providing public register information to enquirers
- investigating possible breaches of environmental law
- assessing customer service satisfaction and improving our service
- Freedom of Information Act or Environmental Information Regulations requests.

We may also pass it on to our agents or representatives to do these things on our behalf.

Disclosure of information – this report will be available to view on-line
If you think this report contains commercially confidential information that should not be placed on our public register, you must contact your local Natural Resources Wales office within **fifteen working days** of receiving this report, using the contact details in the accompanying email or letter. You must give a full explanation of why it should not be added to our public register, including specifying which information is commercially confidential. We will assess your request and respond to you within 20 working days to let you know if we agree to your request.

What do I do if I disagree with the report or have a complaint?
If you disagree with this compliance assessment report, you should contact the lead officer without delay to discuss your concerns.

If you are unable to resolve the issue with the lead officer or their line manager you should contact our Customer Contact team on 0300 065 3000 (Monday to Friday 08:00 – 18:00), or email enquiries@naturalresourceswales.gov.uk for details of how to raise your dispute further through our Complaints and Commendations procedure.

If you are dissatisfied with our response, you can contact the Public Services Ombudsman for Wales by phone on 0300 7900203 or by email at ask@ombudsman.wales

Welsh Language Standards
We are committed to establishing Natural Resources Wales as a naturally bilingual organisation. We will provide compliance reports in your preferred language.