Introduction to INEOS and Grangemouth

Section 1

Introduction to INEOS

Overview

- Flagship British manufacturer of chemicals and oil products, and operates some of the country's most important energy infrastructure
- Anti-dumping claim being brought by the INEOS Olefins & Polymers business, which is based at Grangemouth in Scotland
- Polymers business suffering extensively at hands of dumped imports, and is consequently operating at a loss with imminent threat of closure
- Focus of AD claim is specific to particular grade of polyethylene, known as low linear density polyethylene (LLDPE)
- INEOS is sole UK producer of LLDPE and holds greater than 1% share of UK sales market

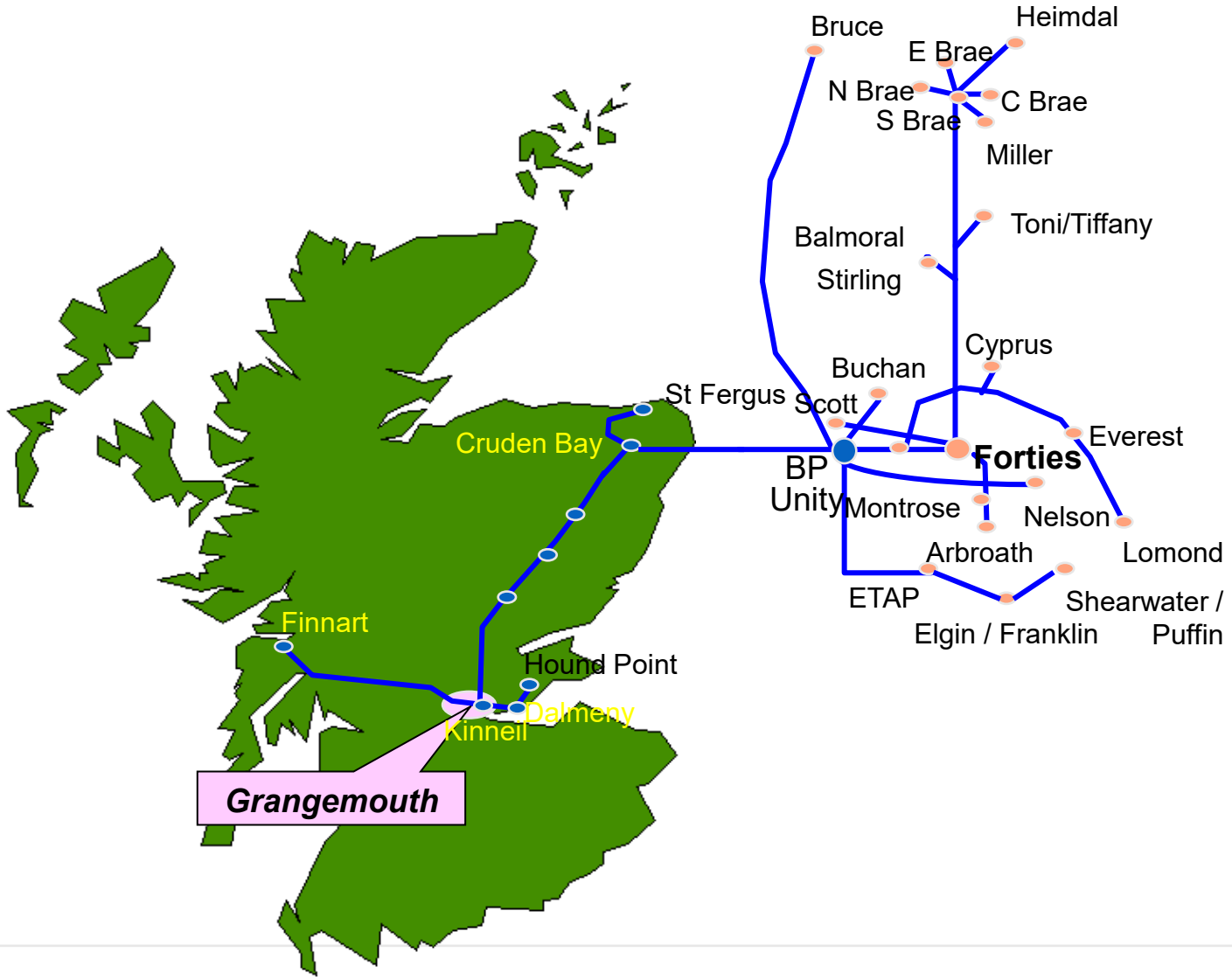
Introduction to INEOS

Overview of Grangemouth Site

- Grangemouth: home of Polymers business, KG ethylene cracker and Kinneil oil terminal, all owned and operated by Ineos and JV partners
- Size of 650 football pitches and is largest employer in region
- Supports numerous other companies in supply chain and downstream, and provides the bulk of Scotland's fuels

Forties Pipeline System

- One of most critical pieces of UK national infrastructure
- Delivers crude oil and gas from North Sea to Kinneil terminal
- Crude oil stabilized at Kinneil terminal and gas separated into saturated hydrocarbon streams
- Saturated hydrocarbon streams fed to gas cracker and converted to monomer units for use in chemical / polymer production



Basics of Polyethylene

Section 2

The Basics of Polyethylene

Manufacturing Process

Natural Gas → *Processing* → Naphtha → *Steam Cracker* → Ethylene → *Polymerisation* → PE (polyethylene) → *Plastics Conversion*

Numerous Applications

- Plastic bags
- Stretch and shrink film
- Food packaging
- Pipe and fittings
- Agriculture wrap
- Fuel tanks
- …

1. **Raw material extraction**
   - North Sea gas extraction via drilling operations provide the essential raw materials for the production of polyethylene
2. **Processing**
   - North Sea gas separation into saturated hydrocarbon streams (ethane, propane, butane) for onward conversion.
3. **Steam cracking**
   - Saturated hydrocarbon stream conversion to unsaturated hydrocarbon streams (predominantly ethylene, propylene) which are the 'building blocks' to most chemical products.
4. **Polymerization & extrusion**
   - Ethylene is polymerized to polyethylene (PE) and extruded into plastics pellets.

INEOS O&P UK
"Innovene 4", PE asset

5. **Plastics conversion**
   - PE pellets are converted by Ineos' customers into final products used for packaging, construction, agriculture and others

The Basics of Polyethylene

Overview of Product

What is polyethylene?

- Polyethylene is the most widely used plastic in the world. It is a **thermoplastic polymer** made from the polymerization of **ethylene (C_2H_4)**, which is a simple hydrocarbon gas.
- Its versatility, cost-effectiveness, and range of physical properties make it suitable for numerous applications, including packaging, bio reactor sacks, sports pitches, industrial pipes.

Key Structural Factors

- **Chemical structure:** Long chains of repeating ethylene units (**$–CH_2–CH_2–$**).
- **Crystallinity:** Varies depending on branching and molecular weight, affecting density and mechanical properties.
- **Mechanical properties:** Toughness, flexibility, and resistance to chemicals and moisture.

The Basics of Polyethylene

Different Grades and End-use Applications

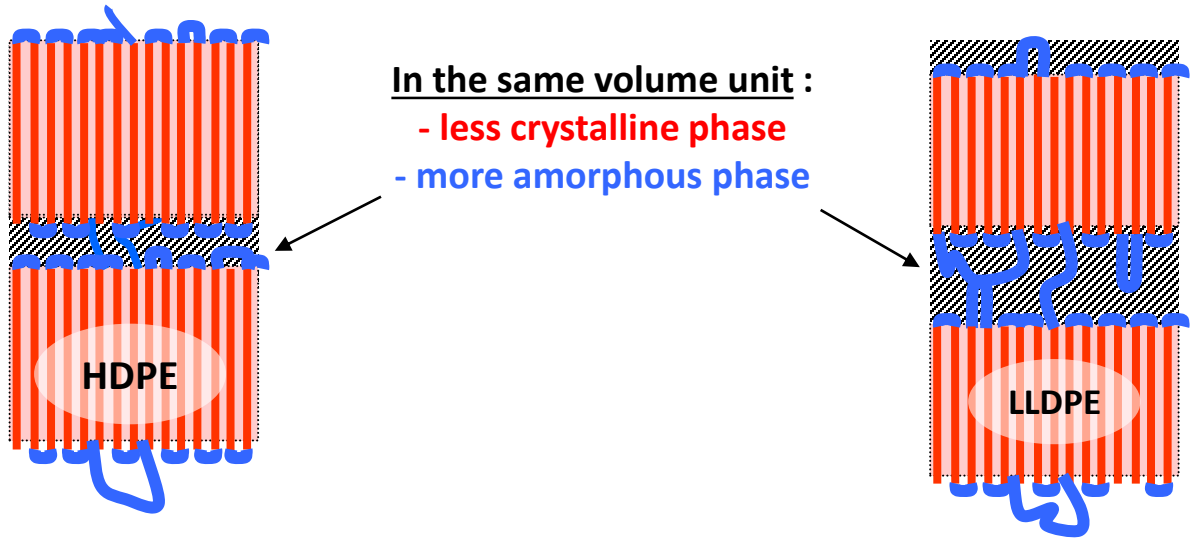
Main Grades

- **HDPE (High-Density Polyethylene):**
  - High crystallinity, stiff, strong.
  - Used in rigid packaging, pipes, containers, stiffness enhancer in food packaging.
- **LLDPE (Linear Low-Density Polyethylene):**
  - Linear (longer) backbone chains with short-chain branches
  - Tough, puncture-resistant
  - Used in covid vaccine bio reactor sacks, cable jackets, heat pump casings, hockey pitches, industrial film, sileage stretch film, pallet shrink-wrap, refuse bags, food packaging
- **LDPE (Low-Density Polyethylene):**
  - Highly branched, low crystallinity.
  - Flexible
  - Used in films, bags, coatings

➢ Focus of AD claim is LLDPE

Crystalline Structure

Tie molecules and crystallinity influence toughness and crack resistance. Distinction in crystalline structure brought about through cooling process and other structural factors determines the grade to be produced



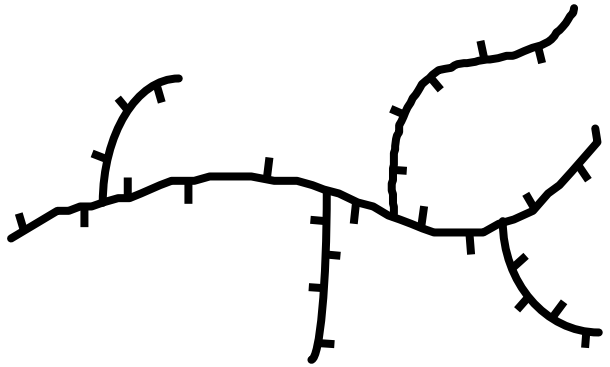
The Basics of Polyethylene

Polyethylene(s)

LDPE

Density = 915-935 kg/m^3

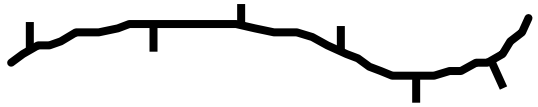
LCB (Long Carbon Branches)
1000-10000 carbons



LLDPE

Density = 900-935 kg/m3

~20 SCB (Short Carbon Branches)
Per 1000 Carbons



HDPE

Density = 935-965 kg/m3
MDPE sometimes used for
930-940 kg/m^3 interval

0-6 SCB per 1000 Carbons

The Basics of Polyethylene

LLDPE Comonomer Variants

Comonomers

LLDPE is made by copolymerizing ethylene with a comonomer. Different variants of comonomer used for this, each giving rise to slight differences in tensile strength

- **C4 (butene)**
- **C6 (hexene)**
- **C8 (octene)**

All variants should be treated as like goods for trade remedies purposes

Interchangeability

(a) *Physical properties*
- LLDPE supplied to customer as plastic pellets - all variants **look identical,** including in terms of size, colour and clarity (owing to same level of crystallinity in structure)
- All variants have similar density
- All variants have linear backbone with short-chain branches

(b) *Demand side*
- C4, C6 and C8 **suitable for many of same end-uses**, for example in refuse sacks, liners and other film applications where performance margins are flexible.
- For certain applications with more sophisticated performance requirements (eg cable jackets), customer may select different combinations of C4, C6 and C8 (with price still being key driver) and **blend according to the strength required.** Additives, blends, and multilayer structures allow buyers to tailor performance **regardless of comonomer type.**
- C4, C6 and C8 are each **suitable for all conversion processes** used by customer to convert pellets to end product (eg extrusion, lamination or injection moulding).
- Same route to market for all LLDPE variants

(c) *Supply side*
- Similar stages of production process used for all LLDPE variants
- Different suppliers use different technologies for polymerization stage (gas phase, liquid solution or slurry loop) and **all 3 LLDPE variants can be produced from each process**
- Different catalysts can be used in production process – again these are interchangeable between the 3 variants