PLASTIC MATERIAL AT THE SERVICE OF CHEESEMAKERS

VOLUME 1/2

SERVI DORYL
CHEESE MOULDS EXPERT

SUMMARY

THANKS

This white paper was written thanks to the research and work of our R&D Manager, **Elodie Perry**, Doctor and Engineer in plastics processing, as well as that of our QSE Manager, **Clovis Dallais**.

Their commitment and expertise were essential in bringing this white paper to life.

We would also like to warmly thank **Colette Breysse**, Packaging Laboratory and Clermont Site Manager of the IPC, for her valuable contribution to this project.

And finally, we send our sincere thanks to **Anne Balquet**, Head of the IPC economic intelligence unit, for her commented proofreading.

2024 Version

INTRODUCTION

After the publication of our **first white paper dedicated to cleaning cheese** molds, our customers and partners have shown **keen interest** in **deepening their understanding of plastic**.

Aware of the importance of this knowledge, since Servi Doryl cheese molds are made of plastic and these interact directly with the cheeses, we decided to respond to their request with an **in-depth explanation.**

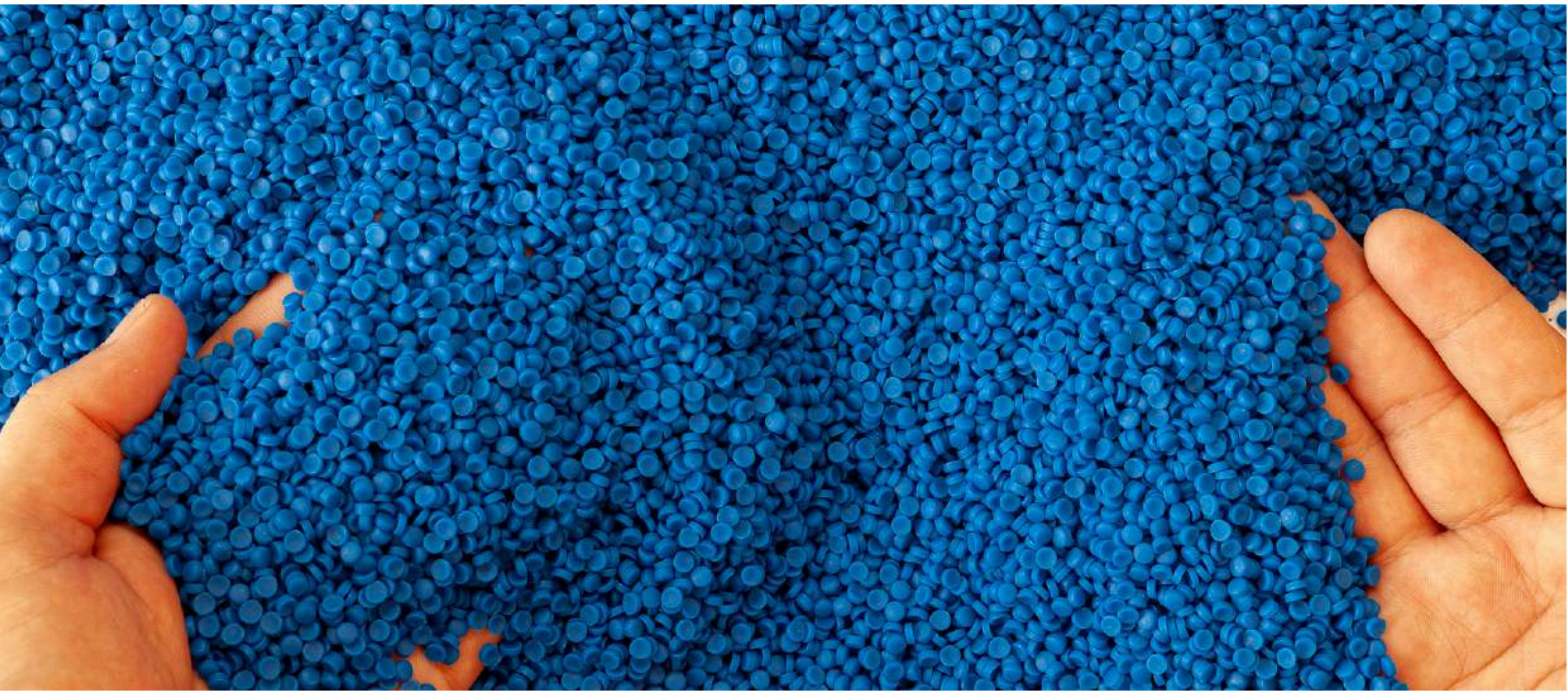
Plastic material is much more than a simple component since it is currently the essential component of our products. This is why we have chosen to devote not one, but **two volumes** to its study.

In this **first volume**, we will discuss the ins and outs of plastic in the specific context of our cheese molds.

We will explore its **fundamental properties**, its **impact on the quality of finished products** and its crucial **role in the manufacturing process.**

The **second volume** in our series will look at essential aspects such as the **choice of plastic materials**, their **durability** and their **recycling**.

We aspire to provide our readers with a holistic view of the issue, thereby arming them with the knowledge necessary to make informed choices in the field of cheesemaking.



PART I

1. WHAT IS PLASTIC?

Plastic material: Mixture comprising, as a fundamental component, a macromolecular substance (polymer) and having, in general, the property of being molded or modeled (*Encyclopédie Larousse*)

1.1. THE POLYMERS

Polus: several   Meros: units, parts

Polymer (n.m.) masculine noun (Greek polumerês)

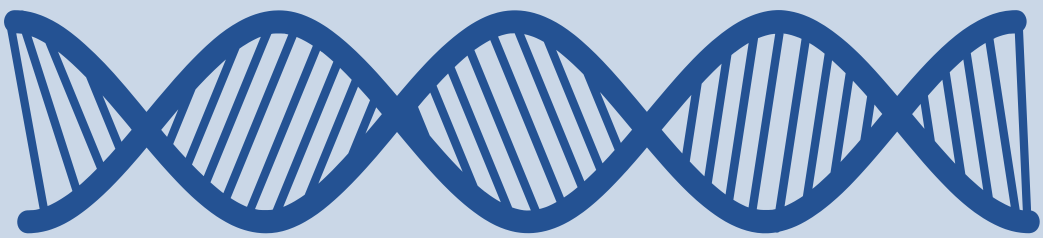
Polymers are macromolecules (very large molecules) made up of the repeated sequence of the same unit, the monomer (mono, only one, meros, part) linked to each other by covalent bonds. The chain length is large enough that the properties are constant even with the addition or elimination of a small number of repeating units (N>>50) (for standardized definitions, ISO 472:2013/Amd 1: 2018).

For a better representation, we can **imagine a large pearl necklace** or a train with many carriages.

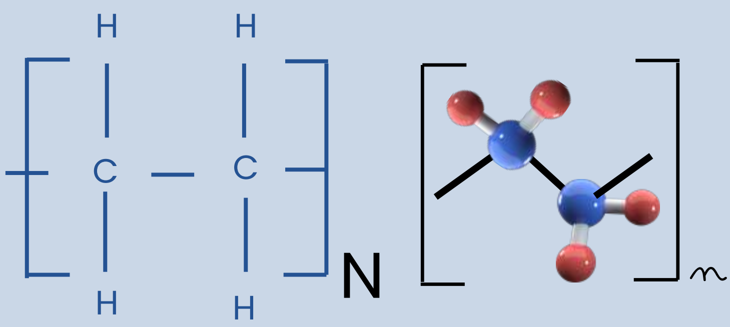
These very large molecules are very numerous and entangled like in a plate of spaghetti to constitute matter.

Polymers can be synthetic (produced by chemical synthesis) or natural (found as they are in nature).

Example of a natural polymer: DNA



Example of synthetic polymer: poly(ethylene)

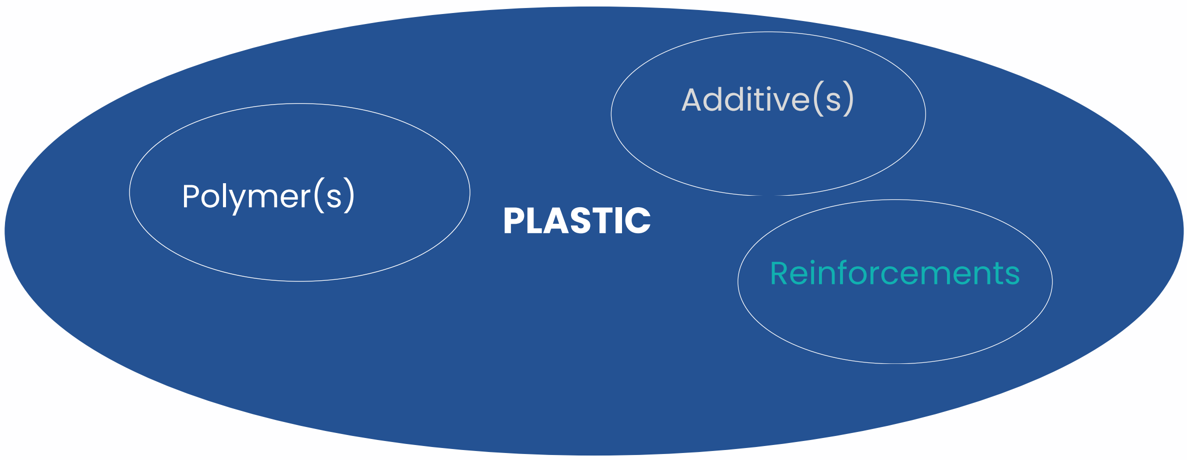


1.2. THE PLASTIC MATERIAL = A POLYMER + ADDITIVES

Plastic (Greek plastikos, which can be modeled, shaped)

Materials commonly called “plastics” or “plastic materials” are materials containing, as their main **constituent, a polymer.**

They generally have the property of being able to be **shaped or molded.**



Plastic materials are mostly formulated by incorporating **adjuvants** (or additives). We speak of fillers (often mineral) when these are integrated in high concentration. Plastic material when highly formulated is also called “compound”.

Adjuvants are added to polymers for multiple reasons (*Carette, 1993*):

- **Modifying or improving the properties of materials:** making a material more flexible or softer with plasticisers, obtaining fire-resistant materials with flame retardants, modifying mechanical properties to adapt them to the intended application with reinforcements, etc.
- **Improving processing and application conditions** (blowing agents, mould release agents, etc.)
- **Reduce the cost of plastics**

There are **many families of additives** depending on their effect, of which here is a non-exhaustive list:

- Plasticizers
- Antioxidants
- UV stabilisers
- Lubricants
- Dyes and pigments
- Mineral fillers
- Reinforcements

- Implementation aids, for example mold release agents
- Metal deactivators
- Flame Retardant agents
- Antistatic agents
- Blowing agents
- Nucleating agents
- …

Example of PVC

Depending on the additives used, PVC can be flexible or rigid.
Soft PVC, for example, contains a high proportion of plasticisers as well as stabilizers. We will find it in floor coverings for example. The rigid, for its part, is, for example, extruded into window profiles.

The plastic materials used for cheesemaking equipments are also formulated but the formulation is highly controlled because all additives must be compatible with food contact.

1.3. THERMOPLASTICS

There are **two main families of polymers**: t**hermoplastic polymers and thermosetting polymers.**

This document presents **thermoplastic** materials. These are the most common materials that are used for cheesemaking equipment. These have the ability to **melt under the action of heat and harden** as they cool down.

On the contrary, **thermosetting polymers harden under the action of heat to reach an irreversible solid state** (network). These include, for example, silicone molds, polyurethane padding foams or epoxy resins…

2. HISTORY

The first synthetic plastics were developed at the **end of the 19th century**. They **took off in the middle of the 20th century.**

This story is too long to detail here but it is interesting to focus on a few **key developments.**

CELLULOID **1869**

Celluloid was synthesized for the first time in Albany in 1869. It was the Hyatt brothers who mixed nitrocellulose with camphor under pressure. They then obtain a solid material that can be worked with the same tools as wood, horn and ivory. Celluloid is used as a substitute for ivory for the manufacture of pool balls but also for dental applications. The Celluloid® brand name was registered in 1872. Celluloid is regularly presented as the first synthetic plastic material in history (Michel, 2015).

1907 BAKELITE

Bakelite takes its name from the American chemist Leo Hendrik Baekeland who developed it. The first syntheses of this material were carried out in 1907 from phenols and formaldehyde. This is qualified as a thermosetting plastic (hardened irreversibly under the action of heat), it is very heat resistant, electrically insulating, light and semi-transparent. It replaces porcelain or celluloid in their applications. One of the best-known applications is that of the telephone developed in 1930 (Lavoisiy, 2002).

INJECTION MOULDING **1930**

First injection moulding machine in France In the 1930s, the first injection presses started in France in Oyonnax (the heart of plastics processing in France, "Plastics Valley"), particularly for the production of glasses. The patent for the first injection molding machine dates from 1872. And the inventors are none other than the Hyatt brothers (at the origin of celluloid). (Polyvia, 2023).

POLYETHYLENE

1933

Low density polyethylene (LDPE) was first synthesized in 1933 in the laboratories of I.C.I. by E. Fawcett and R. Gibson. The process used high pressures and oxygen as a catalyst.

High-density polyethylene (HDPE), as it is currently produced, dates from 1953. Karl Ziegler, at the Max Planck Institute, developed a low-pressure synthesis process using catalysts (Ziegler-Natta) .

THE LEGO®

1949

In 1949, Lego introduced its first plastic brick. Previously, Lego toys were made of wood (LEGO, 2024).

KEVLAR®

1965

It was in 1965 that researchers Stéphanie Kwolek and Herbert Blades developed Kevlar® for the Dupont de Nemours company. It is found in particular in bulletproof vests or firefighter jackets.

PLASTIC PROCESSING

1988

Introduction of the triangluar recycling symbols relating to plastics

BIOPLASTICS

1990

The development of bioplastics began in the 1990s with the development of PLA and PHA. These materials, which have been in development for more than 30 years, still occupy a limited place on the thermoplastic materials market.

GREAT PACIFIC GARBAGE PATCH

1997 (GPGP)

Captain Charles Moore discovered the “seventh continent” in 1997. It is a gigantic mass of plastic waste that has accumulated in the middle of the Pacific Ocean. Its surface area is currently estimated at three times the surface area of mainland France. Since this discovery, numerous efforts have been made to stop this pollution. Actions are being taken to reduce the use of plastics (laws in different territories, particularly for single-use plastics) but also to recycle them (example of the extension of sorting instructions in France in recent years) (Matos, 2021) .

3. ORIGIN AND SYNTHESIS

3.1. NATURAL POLYMERS

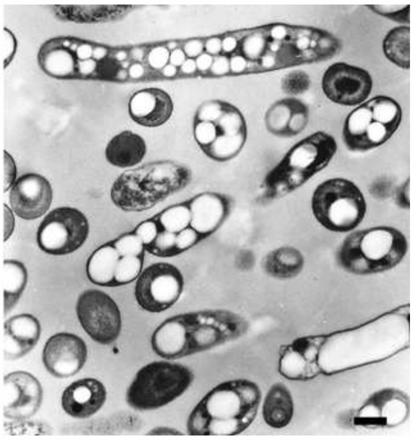
There are **polymers directly present in nature**. These are produced by living organisms (plants or animals). We find, for example, in plants, cellulose (wood, stems, etc.) and starch (energy storage).

Natural rubber is taken from rubber trees. Crustaceans are made of chitin. Chitin would be the second most synthesized polymer in the living world behind cellulose. Its annual global production by marine crustaceans is estimated at 2,3.10e9t (~1 g/year/m2) of which 90% is attributed to zooplankton and krill.

Examples:
Cellulose, amylose, amylopectin, natural rubber, starch, chitin...

These **natural polymers** can be **as they are or modified**. These are known as **artificial polymers**. Cellulose is, for example, transformed to produce viscose or Cellophane®.

Natural polymers can also be synthesized by microorganisms. This is the case for polymers from the poly(hydroxy alkanoate)s PHAs family. The micro-organisms are fed with sugar derivatives and stressed (diet/food alternation). They will then store energy in their cells in the form of polymers.



At the end of the culture, the cells are broken (lyses) in order to recover the polymers. This family of polymers is not yet produced in large quantities but it is biodegradable, particularly in the marine environment.

CAUTION

Be careful of the terms “biopolymer” or “bioplastic” which do not have a precise definition and can sometimes lead to confusion.

Under these terms, we can find:

- Natural polymers (e.g.: cellulose)
- Synthetic polymers but derived from biomass (artificial) (e.g. poly(lactic acid) (PLA))
- Biodegradable polymers (these polymers degrade in a given environment), but their raw material can be both bio-based (for example starch) and petro-based (for example PBAT).
- Or even biocompatible polymers which are developed to be compatible with living tissues (prostheses, implants, contact lenses, etc.)

3.2. MONOMERS FROM OIL/GAS

Most plastics are currently obtained by polymerising monomers derived from oil and gas.

Three main steps are necessary to obtain these monomers:

1

1.Crude oil **extraction**

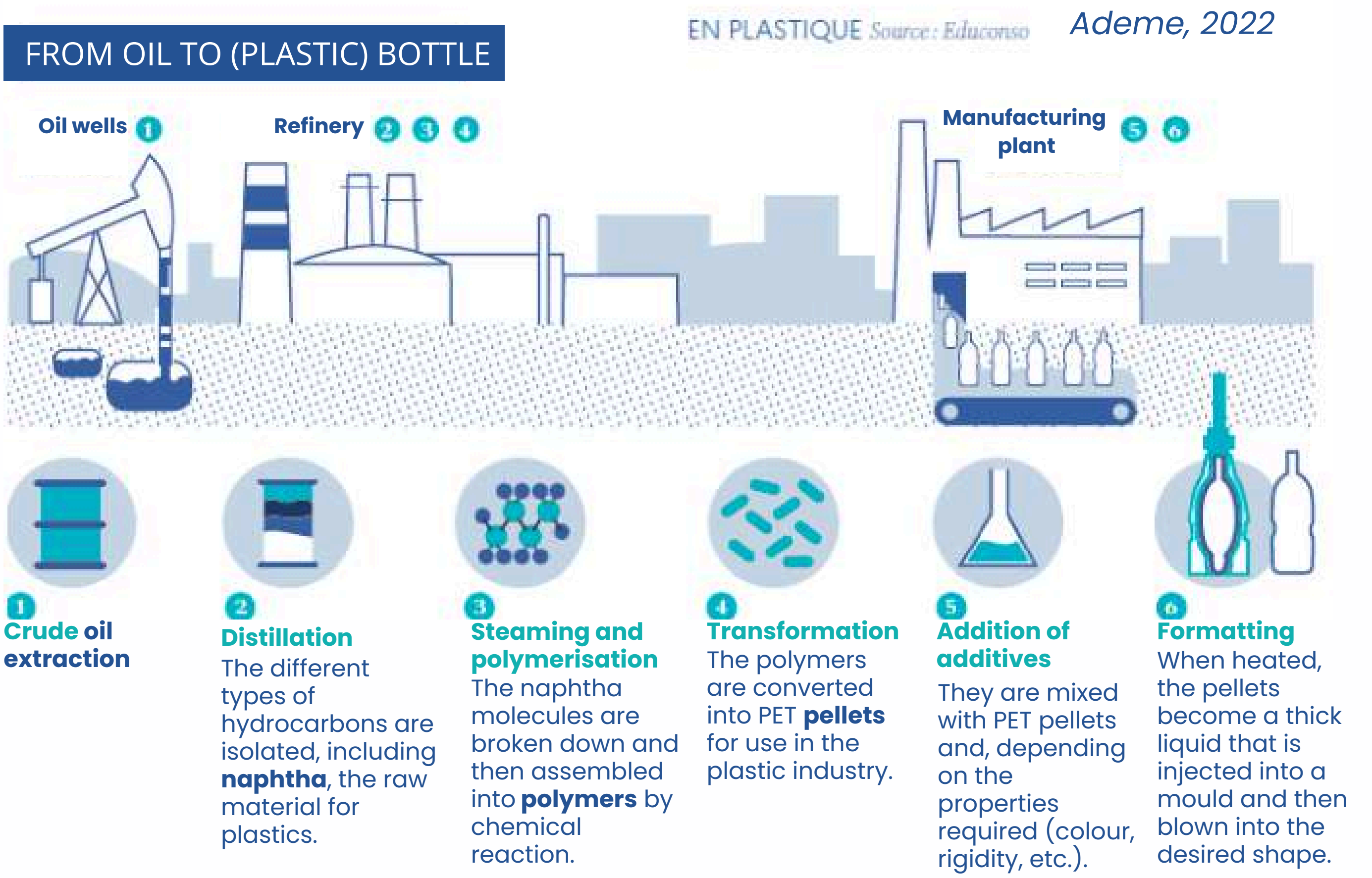
2

Refining by distillation to isolate naphtha (fraction which condenses between 180 and 300°C). The other fractions are fuel oil (used for heating), diesel, kerosene and gasoline (used for transport).

3

Steam cracking (cracking by water vapor) of naphtha produces small molecules: ethylene, propylene, styrene, etc.

According to ADEME, it takes 1,9 kg of crude oil to produce 1 kg of plastic bottles (ADEME, 2022). **Plastics consume between 5 and 10% of the world's oil and gas resources**. According to UNEP (United Nations Environment Program), this could represent 20% in 2050.



Ademe, 2022

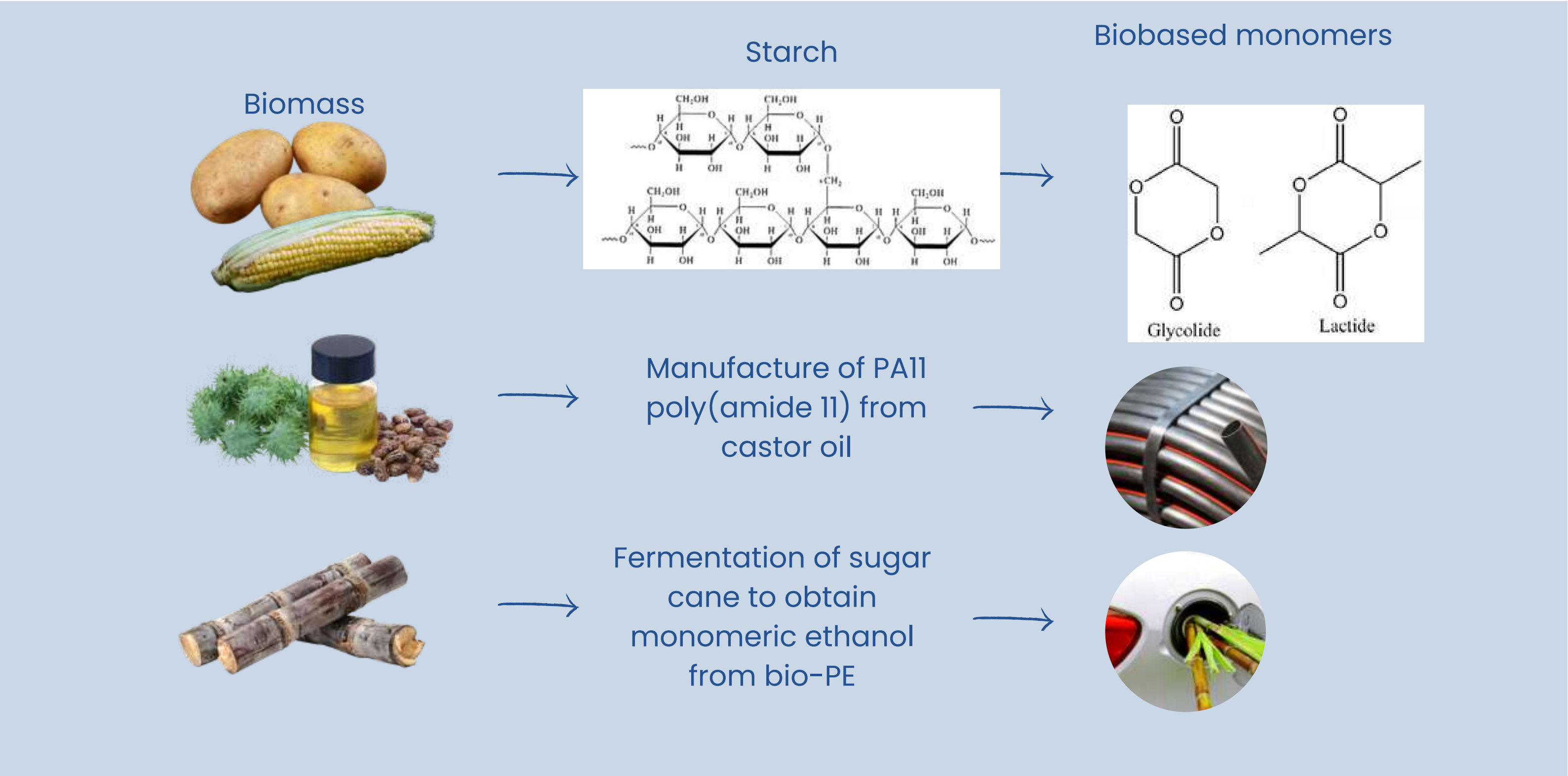
Plastic cheesemaking equipment mainly comes from monomers derived from oil and gas: ethylene and propylene.

3.3. MONOMERS FROM BIOMASS

It is also **possible to use monomers from biomass** (plant or animal), these are **biobased monomers**. These monomers, like petro-based monomers, are then polymerized to make polymers.

Several **examples of biobased monomers** can be cited:

Resource	Monomer	Polymer	Example of producer
Com	Lactic acid	Poly(lactic acid) (PLA)	Natureworks
Castor oil	Sebacic acid	Polyamide-11 (PA-11)	Arkema
Sugar cane	Ethanol	Polyethylene (PE)	Braskem
Milk	Casein	Water-soluble polymer	Lactips



For **biobased polypropylene**, **production** is still **low** and rather at the experimental stage.

For example, in 2019, LyondellBasell and Neste produced bio-PP with vegetable oil and oil co-products, made in Germany. Or again, Mitsui Chemicals (Japan) has imagined a new production scheme for bio-PP (biomass fermented into isopropanol which is then dehydrated to obtain propylene).

The majority of PE and PP are petro-based, some are biobased but production is still low.

Biomass (renewable resources) makes it possible to produce new polymers. But most of the development is focused on biobased monomers to produce traditional polymers (PE, PP, etc.) so that these traditional biobased polymers can directly replace their petro-based counterparts and can easily be reprocessed through recycling channels that already exist (which is not yet the case for PLA for example).

In 2019, **biobased plastics represented 0.75% of global plastic production** (ADEME, 2022).

CAUTION

Biobased does not mean biodegradable.
Biobased does not mean 100% biobased.

A **biobased plastic object is not necessarily biodegradable.** And even though it says "biodegradable," it does not always break down completely. A material is **biodegradable if it can be decomposed by microorganisms** (bacteria, fungi, algae, etc.) **under specific conditions** (defined environment, time and temperature). Some plastics can degrade in a compost bin (such as bags for packaging fruit and vegetables, partially biobased) or in the ground, but they will not necessarily degrade in water... Consequently, **no plastic should be left in nature** !

When a packaging is labelled 'biobased', **the biobased materials content should be carefully** examined. Some packaging claims to be biobased when in fact only 30% of the materials are biobased.

MATERIALS FROM PETROLEUM | **BIO-BASED MATERIALS**

NON-BIODEGRADABLE POLYMERS

4 Non-biodegradable petroleum materials:

- ON
- PP
- PET
- WELL
- [...]

1 Non-biodegradable biobased materials:

- PE ORGANIC SOURCED
- ORGANIC SOURCED PP
- ORGANIC SOURCED PET
- PA ORGANIC SOURCED
- PTT
- [...]

BIODEGRADABLE POLYMERS

3 Biodegradable petroleum materials:

- PBAT
- PCL
- [...]

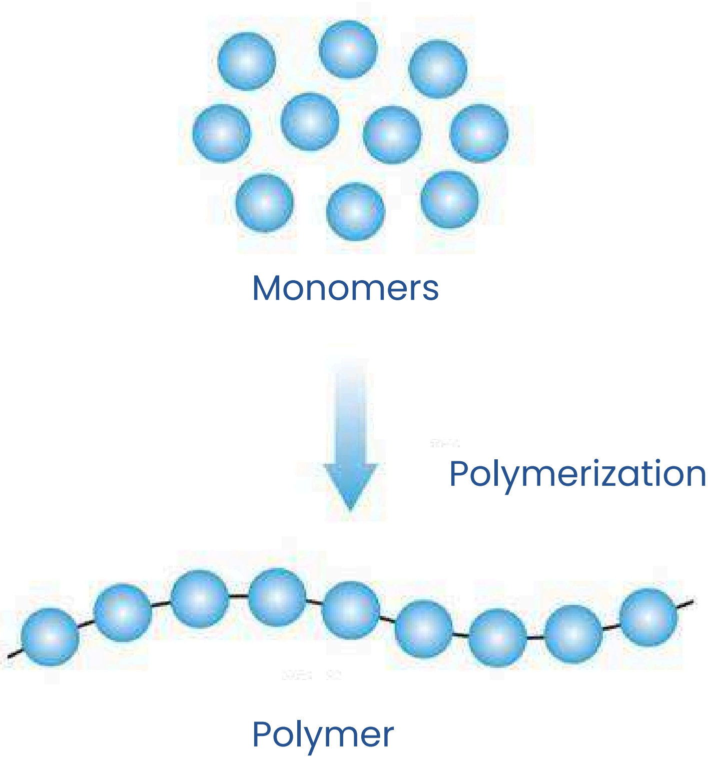
2 Biodegradable biobased materials:

- PLA
- PHASE
- PBS
- STARCH MIXTURE
- [...]

According to the definition of European bioplastics (EuBP), "Bioplastics" include biobased materials, whether biodegradable ( ) or 1 ( ) and bi 2 egradable petro-sourced materials 3 @IPC

3.4. POLYMERIZATION

The chemical reaction of polymerisation enables **monomers to be joined together** to form long molecules: **polymers**. These are most often in the form of granules or powders. Polymers produced by polymerisation are called **synthetic polymers**. These include polyethylene, polystyrene and polyamides.
By **adding adjuvants and additives** to these polymers, we can obtain a variety of plastics that can be **shaped into different forms** (pipes, pots, complex shapes, etc.) using different factory transformation processes (moulding, extrusion, injection or thermoforming, etc.).



4. MAIN THERMOPLASTIC MATERIALS

The main thermoplastic materials are listed in the table below:

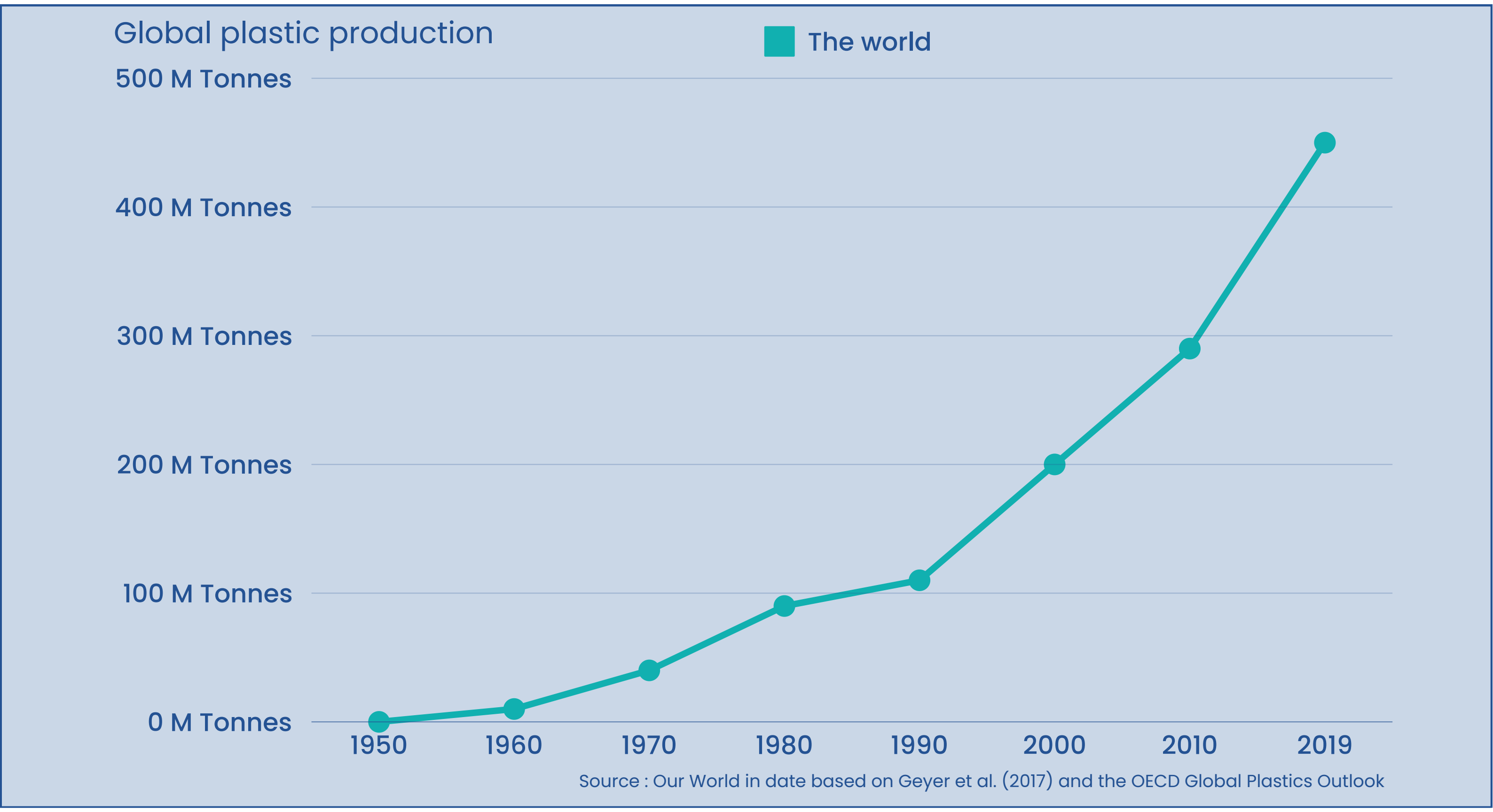
7 MAIN FAMILIES OF PLASTICS

01 PET	**POLYETHYLENE TEREPHTHALATE** Water and soda bottles, disposable packaging, “fleece” clothing...	
02 HDPE	**HIGH DENSITY POLYETHYLENE** Milk bottle, cleaning products, medicine bottles...	
03 PVC	**VINYL POLYETHYLENE** Pipes, windows, doors...	
04 LDPE	**LOW DENSITY POLYETHYLENE** Bags, films and plastic bags...	
05 PP	**POLYPROPYLENE** Plastic parts for computers, cars, etc.	
06 PS	**POLYSTYRENE** Cups, disposable plates, pens, yoghurt pots...	
07 OTHERS	**OTHERS** CD, nylon, acrylic, protective glasses, baby bottles...	

Cheese moulds are mainly made in PE and PP and this choice will be explained in volume 2, chapter 4.

5.THE THERMOPLASTIC MATERIALS MARKET

Global production of plastics increased from 1.5 million tonnes in 1950 to 117 million in 1990 and to 368 million in 2019, **367 million in 2020** (*Plastics the facts 2021*). The OECD figures are a little higher with 460 millions tonnes produced in 2019 (OECD, 2023). This **evolution** has been **dazzling** over a relatively short period of time scale (70 years).



OECD projections predict plastic use of **1,231 million tonnes of plastic will be used by 2060, representing a tripling of plastic consumption.**

European production represents 55 million tonnes in 2020 (Plastics the facts 2021), or **15% of global production**.

The three largest plastic processors in Europe are **Germany, Italy and France**. Together, they represent 46.7% of European processors in 2020.

France is among the largest consumers of plastic in Europe with 4.8 million tonnes used per year, or 70kg/inhabitant per year.

Plastic materials are present in all major industrial sectors. They cover many areas of application. In **Europe, the three largest sectors of activity using plastic materials** are:

- Packaging – 40%
- Construction sector – 20%
- The car – 9%

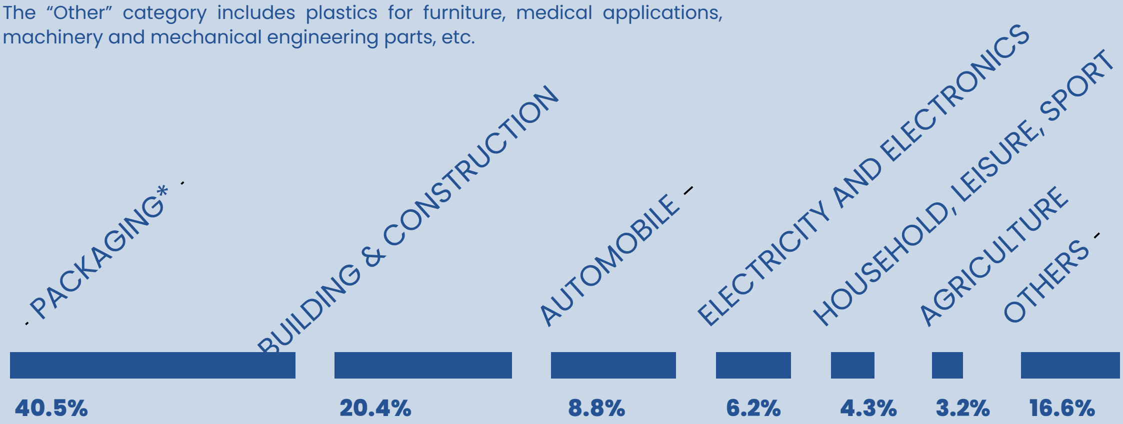
It should be noted that durable cheesemaking equipment is not in these categories and should not be associated with packaging.

EU 27+3 converts demand for plastics

BY SECTOR IN 2020

Packaging and construction represent by far the largest end-use markets.

The third end-use market is the **automobile industry.**
The "Other" category includes plastics for furniture, medical applications, machinery and mechanical engineering parts, etc.



*Including commercial and industrial packaging Source: Plastic Europe Market Research Group (PEMRG) and Conversio Market & Strategy GmbH Demand estimates do not include recycled plastic

Total 49.1Mt

These distributions by sector are very close on a global scale and on a French scale.

It should be noted that **plastic** is currently the **3rd most produced material in the world behind cement and steel.**

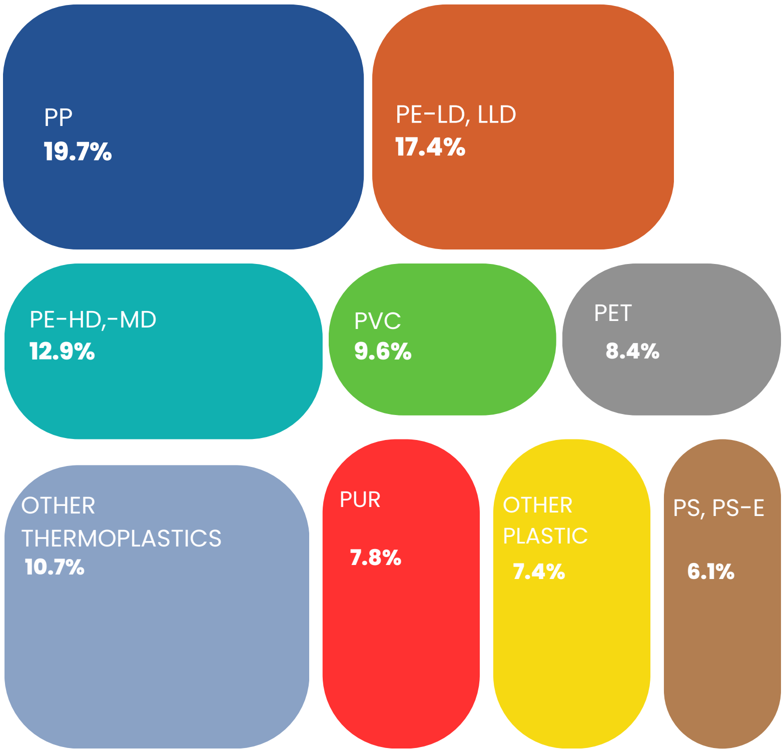
If we look at the major families of plastics, we see that polyolefins represent 50% of the European market with:

- 20% of PP
- 17% HDPE
- 13% the PEHD

DISTRIBUTION BY POLYMER TYPE IN 2020 IN EUROPE

EU 27+3 converts demand for plastics

DISTRIBUTION BY TYPES OF POLYMERS 2023



Source: Plastic Europe Market Research Group (PEMRG) and Conversio Market & Strategy GmbH Demand estimates do not include recycled plastic

PP | Food packaging, packaging for sweets and snacks, hinged caps, microwave containers, pipes, automobile parts, bank notes, etc.

PE-LD, LLD | Reusable bags, trays and containers, agricultural film, food packaging film

PE-HD,-MD | Toys, milk bottles, shampoo bottles, hoses, household items, etc.

PVC | Window frames, profiles, floor and wall coverings, pipes, cable insulation, garden hoses, inflatable swimming pools, etc...

PET | Water bottle, soft drinks, fruit juices, cleaning products, etc...

PUR | Building insulation, pillows and mattresses, insulating foams for refrigerators, etc...

OTHER PLASTICS | Includes other thermosets such as phenolic resins, epoxy resins, melamine resins, urea resins and others.

PS, PS-E | Food packaging (dairy and fishing products), insulation of buildings, electrical and electronic equipment, interior lining of refrigerators, spectacle frames, etc.

OTHER THERMOPLASTICS | Hub cover (ABS); optical fibers (PBT); spectacle lenses, roofing plates (PC); touch screens (PMMA); cable coating in telecommunications (PTFE); and many others in aerospace, medical implants, surgical devices, membranes, valves and seals, protective coatings, etc...

The applications of plastic materials have developed exponentially in just a few decades and have “seduced” all sectors of activity. It is worth looking at the reasons behind the enthusiasm for this material.

The development of Servi Doryl's activity, having started in 1972, is directly associated with the significant growth of plastic materials in the second part of the 20th century.

WHY IS PLASTIC EVERYWHERE? HERE ARE SOME REASONS:

- Plastics are **lightweight** and therefore easy to transport (compared to glass for bottles, for example).
- They are **stronger** than some materials and often more **resistant** to humidity (compared to wood, etc.).
- They can bu used with a **wide range of flexibility, appearance and méterials.**
- They allow **good food preservation.**
- **The cost of production is low**

However, it is legitimate to **question of the sustainability** of this sector in the current global context. A great deal of work is being done by governments and companies to make the consumption and use of plastic more “responsible”.

6. THE PROCESSING OF THERMOPLASTIC MATERIALS

Thermoplastics come in **powder or granular form**. They **melt under the action of heat** and shear stress and can then be **shaped in a mold.**

The main processing techniques are:

- Thermoplastic injection
- Extrusion of films, sheets and plates
- Extrusion of tubes and profiles
- Plastic boilermaking
- Injection-blowing
- Extrusion blow molding
- Thermoforming
- Rotomolding

In this chapter we will focus on the **techniques** that are **most used for making cheese moulds.**
A focus will also be placed on **additive manufacturing** (3D printing).

6.1. THERMOPLASTIC INJECTION MOULDING

Injection moulding enables finished parts with complex shapes to be produced in a single operation, with weights ranging from a few grams to several kilograms. The main areas of application are industrial parts for the automotive, electronics, robotics, aerospace and medical industries.

PRINCIPLE

The **pellets** are introduced through a hopper into a screw rotating in a heated barrel. The **molten material** is then **introduced under pressure** into a closed mold (use of the screw as a piston). The plastic material is then kept under pressure and then cooled in the mold before the part is ejected.

An explanatory video on thermoplastic injection is available on the Polyvia Formation website under the heading "Plastic processing techniques" :
https://youtu.be/bF91pd_nbi4

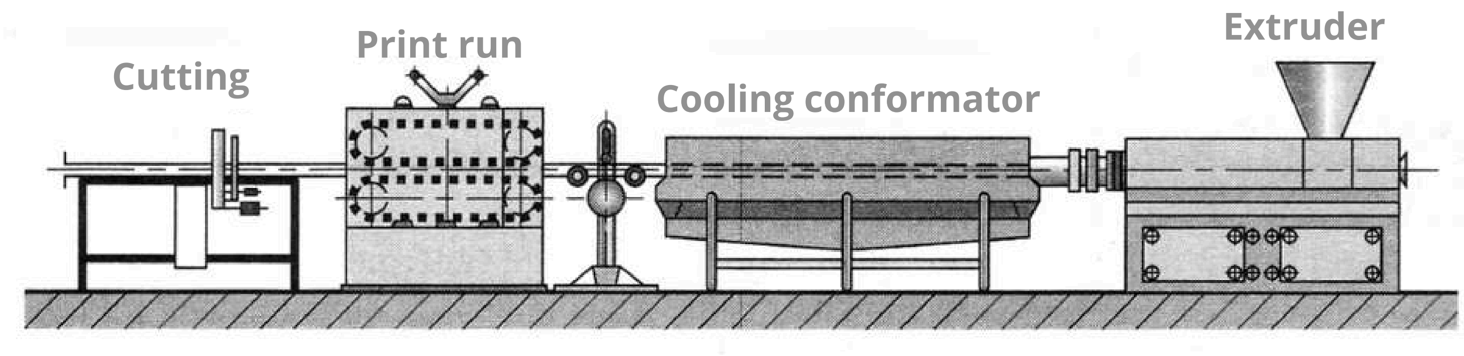
Examples: telephones, bins, hoods, casings, boxes, cheese molds, etc.

6.2. EXTRUSION

It is a **continuous, rapid and inexpensive manufacturing technique**. We can manufacture films, sheets and plates but also very long products: profiles for doors and windows, pipes, cables, tubes, joints, grills, etc.

PRINCIPLE

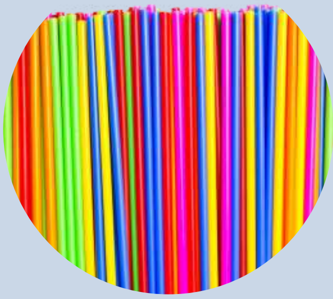
Polymer pellets are heated and sheared by a screw that rotates in a heated barrel and pushes the plastic toward something called a die.
The molten material is pushed through the die and then cooled to keep the transformed shape. It is the same principle that is used to make pasta or semolina.



An explanatory video on thermoplastic extrusion is available on the Polyvia Formation website in the "Plastic processing techniques" section: **https://youtu.be/pZbbkkbfIdA**

Examples

Extrusion of films/sheets, tubes, hollow profiles, solid profiles, rods (granules)...



6.3. PLASTIC BOILERMAKING

Many techniques are used in **plastic boilermaking**: welding, bending, assembly, etc.
Very diverse parts are manufactured: pipes, displays, tanks, cheese moulds, etc.

6.4. ADDITIVE MANUFACTURING

Additive manufacturing (or 3D printing) is a fairly **recent** family of transformation processes that enables to use **all types of materials**: plastics, metals, ceramics, concrete, etc.

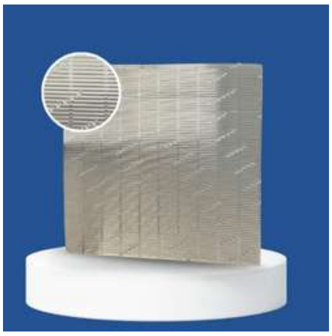
The term "**additive manufacturing" is used in industry**, while the equivalent term "**3D printing**" is used in a "**general public**" context or in the media.
It is based on the principle of adding material. The object is then created layer by layer until the final design is obtained.

It responds in particular to the needs of **prototyping** (rapid production time), **complex parts and/or small series parts.**
Many techniques are grouped under the term additive manufacturing.

We can cite **three major ones**:

- Fused Filament Fabrication (FFF)
- Selective laser sintering SLS)
- Stereolithography (SLA)

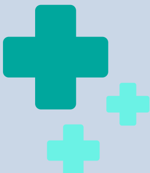
This technique has taken off in all companies and also among the general public. When appropriate, Servi Doryl offers to create prototypes using additive manufacturing (to find out more, see our article dedicated to prototyping).



Cheese draining mat made in 3D for a Servi Doryl client

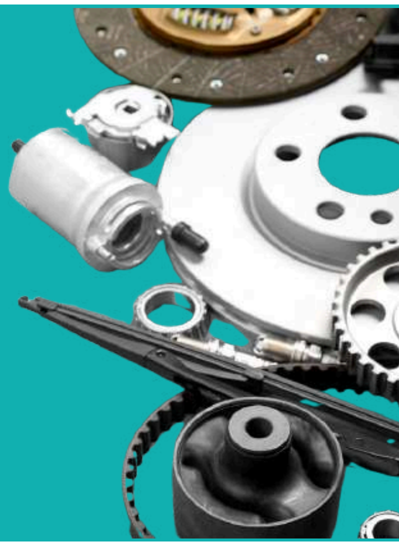
An explanatory video on additive manufacturing/3D printing is available on the Polyvia Formation website in the "Plastic processing techniques" section: **https://youtu.be/pi6dk9SQDp0**

Examples:



Medical sector:
custom-made dental implants or prosthesis

Transports:
automotive parts manufactured using additive manufacturing, design...



PART II

Making cheese requires using **specific equipment**. This equipment is varied, whether it is used for curdling milk, molding cheese, draining, salting or maturing. The constituent materials have evolved over time. The wood used historically has gradually been replaced by metal (aluminum and stainless steel) and plastic. Certain materials remain very specific for certain stages (*Androuet, 2022*).

IIn recent years, **the dairy industry** has undergone **a number of structural changes**. The **number of dairy farms has fallen**, while **milk volumes and the proportion of dairy products exported have continued to rise**. Cheese factories have become **more industrialised** , and **equipment specifications have changed as a result.** Requirements in terms of **sustainability, quality** and **hygiene** have increased.

We have to be increasingly **flexibl**e in order to produce different cheeses on the same production line, for example. There are also increasing demands for **sustainable development and improvements in greenhouse gas emissions.**

This chapter covers the key points of the **equipment specifications**. This will help us to understand why plastic has taken such a prominent place in cheese-making workshops.

1. GENERAL

Specific features of the equipment used to make the cheese :

Conception
- Possibility of colouring
- Made-to-measure design (different sizes and shapes for different cheeses and technologies)
- Can be mechanised for industrial sites (can be stacked, precise dimensions, etc.)
- Cleanability (the design was conceived with this in mind - no cavities, water has to go everywhere)

Use
- Mechanical resistance to stress
- Resistance to humidity (very humid environment in a cheese factory)
- Temperature resistance (up to 80°C)
- Suitability of curds, whey and cheese for food contact
- Filtration function of the mould (serum evacuation), draining speed influences the quality of the cheese obtained
- Manoeuvrability for manual handling

Cleaning

- Resistance to industrial cleaning (to find out more, do not hesitate to consult our white paper on cleaning moulds in cheese factories)
- Chemical products (detergents, acids and bases up to 5%)
- Temperature/time
- Jet pressure

Lifetime
- Durability: resistance to ageing
- Recyclability

2. SOFT CHEESES

For the production of soft cheeses, the following specific needs can be identified:
- **Varied shapes** for differentiated cheeses (for heart shape of the Coeur de Neufchâtel...)
- **Molding several cheeses at the same time:** moulds block (the various components must be assembled together)
- **Specific equipment:** extensions, blinds, trays, etc.

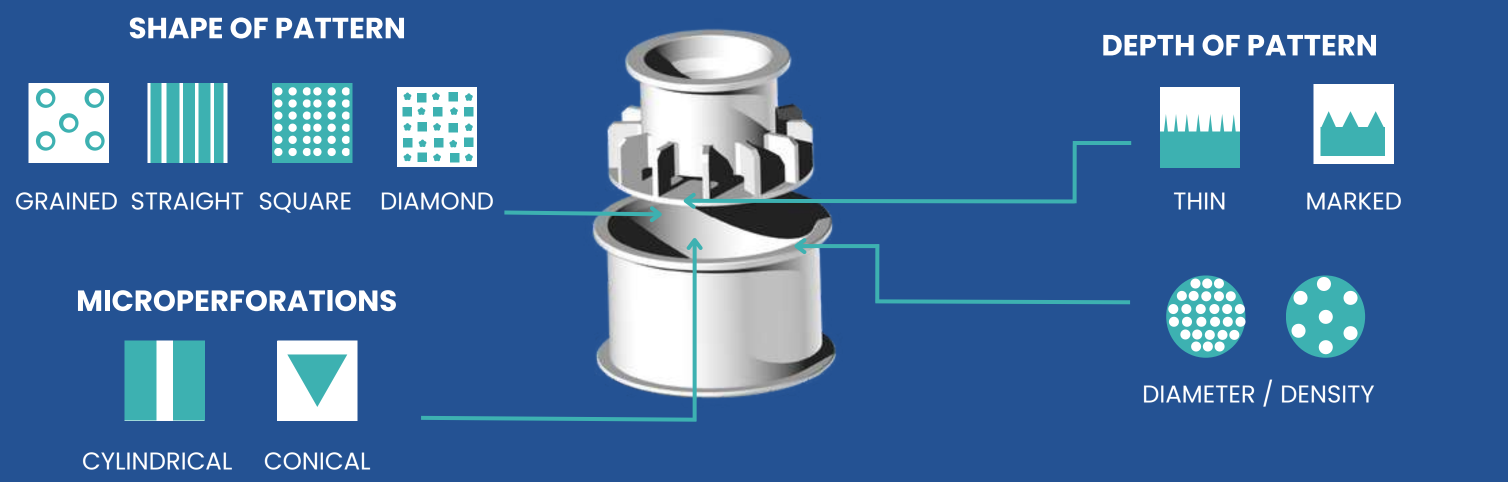
3. PRESSED CHEESES

For the production of pressed cheeses, the following specific needs can be identified:

- **Good mechanical resistance,** particularly during pressing and because certain cheeses are heavy and bulky
- **The mould's filtration function is adapted to cheese-making technology** (whey evacuation), as the draining speed influences the quality of the cheese obtained
- **Different frames and perforations** depending on the cheese to be produced, the desired drainage and the molding technology (wheal moulding, GSV, etc.)

Each cheese needs a specific pattern/perforation combination.
This is why, with our expertise, Servi Doryl has been supporting its clients in making this crucial choice for over 50 years.

40 COMBINATIONS OF PATTERNS & PERFORATIONS



4. SPECIAL REQUIREMENTS

2.1 SPECIFIC USDA REQUESTS

In the US market, regulations are specified by the **Food and Drug Administration (FDA)** (21CFR parts 170-199) but some customers require the material to meet **additional standards**:

- «3-A sanitary standards for multiple-use plastic materials used as product contact surfaces for dairy equipment”.
- USDA Guidelines for the sanitary design and fabrication of dairy processing equipment.
- The main points of these standards concern **food safety and the hygienic design of equipment** (clear and radiated angles, etc.).

2.2 DETECTABILITY

For food safety reasons, some cheese factories are equipped with **metal detectors or X-ray detectors**. Grades of plastic detectable with this equipment are therefore sometimes required in order to be able to detect a piece of plastic in the cheese produced.

To learn more about the different types of detectable trays available at Servi Doryl, follow the link.

2.3 OTHERS

This chapter is not exhaustive and does not cover all cheesemaking equipment such as basins, ladles, trolleys, maturing equipment, etc. In addition, certain cheese productions are specific, such as for fresh cheese or vegan cheese. For these productions, there may be additional requirements.

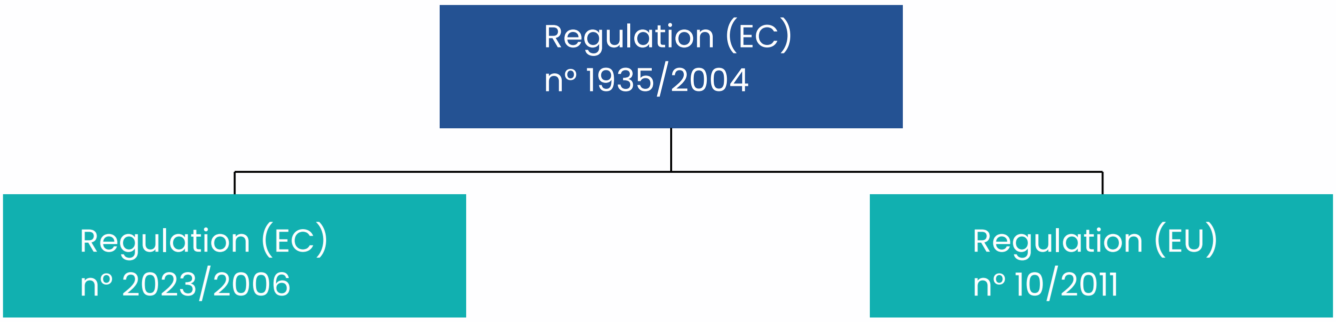
One of the **main constraints is the suitability of the materials for food contact**. This point is developed in the following chapter.

PART III

1. FOOD SAFETY OR SUITABILITY FOR FOOD CONTACT

Food safety or suitability for contact with foodstuffs is governed by **several regulations**; In the case of **cheese mould manufacturing, the three regulations to take into account in Europe are**:

- **Regulation (EC) No. 1935/2004** of October 27, 2004 concerning materials and objects intended to come into contact with food
- **Regulation (EC) No. 2023/2006** of December 22, 2006 relating to good manufacturing practices for materials and objects intended to come into contact with food
- **Regulation (EU) No. 10/2011** of January 14, 2011 concerning plastic materials and objects intended to come into contact with food



1.1 REGULATION (EC) NO. 1935/2004 KNOWN AS "THE FRAMEWORK REGULATION"

Regulation (EC) No. 1935/2004 **defines the general requirements which apply to materials and objects intended to come into contact directly or indirectly with foodstuffs**, food products and beverages placed on the Community market in order to ensure a high level **consumer protection.**

The materials used in the composition of these objects can be of **various types: plastic**, metal, wood, cardboard, etc.

All "materials and equipment used in the production, processing, storage or transport of foodstuffs" are affected by this regulation, including accessories manufactured by Servi Doryl.

It specifies:

- The obligations applicable to the materials and cites the different regulatory texts depending on the materials used. For plastic materials, EU Regulation No. 10/2011 of January 14, 2011 is cited in Appendix 1.

- The obligation for materials and objects listed in Annex I of the regulation to be accompanied by a written declaration of conformity. It brings together all the elements providing proof of regulatory compliance. In the case of plastic cheese moulds, details regarding the information to be provided are indicated in EU Regulation 10/2011 (formulation, verification conditions, restrictions on use, etc.).

- The obligation for the manufacturer to declare that it complies with the rules of good practice described in EC Regulation No. 2023/2006 and to have a traceability system (article 17).

1.2 REGULATION (EC) NO. 2023/2006 RELATING TO GOOD MANUFACTURING PRACTICES FOR MATERIALS AND OBJECTS INTENDED TO COME INTO CONTACT WITH FOODSTUFFS

Regulation (EC) No. 2023/2006 defines that the **company must put in place a quality assurance and control system** which includes:

- **Verification of staff knowledge** of good manufacturing practices
- **Machine compliance**
- **Control of the conformity of the raw material** and therefore of the different polymers used in the case of cheese moulds
- **Monitoring the application of the rules** of good manufacturing practices and the implementation of a corrective plan for hypothetical deviations.

This **system must be documented.**

1.3 REGULATION (EU) NO. 10/2011 CONCERNING PLASTIC MATERIALS AND OBJECTS INTENDED TO COME INTO CONTACT WITH FOODSTUFFS

Before 2011, manufacturers applied a set of directives including Directive 202/72/EC. These were **replaced by a single European regulation EU 10/2011**.
It regulates plastic materials and articles intended for food contact.

This regulation tells us:

- **Composition criteria**: Positive list of substances that can be used in the production of these plastic materials and articles
- **Limit values** concerning the potential migration of the material towards the food
- **Details of the content** of the declaration of conformity
- **Details on the conditions** to be applied for the inertia criterion tests of materials depending on the foodstuffs in contact and the conditions of contact and use

This **regulation is frequently updated**, which is why it is essential to keep a regulatory watch.

2. CONFORMITY TEST OF THE MIGRATION OF SUBSTANCES CONTAINED IN PLASTIC TO CHEESE MOLDS

2.1 INTRODUCTION

The principle is to **check that the packaging does not release any substance that could constitute a risk for the health of the consumer** : this is the **principle of inertia.**

The first step is to **collect information from the suppliers**. A **food safety certificate** for the plastic material used proves that the formulation complies with EU Regulation 10/2011. Next, it is necessary to verify that **migration levels are below regulatory thresholds.**

In our case, the cheese mould must neither transmit dangerous substances to the curd nor to the whey. For this, migration tests are carried out. During these tests and for reasons of ease of implementation, the cheese is replaced by various simulants (see section 2.2 “Choix du simulant”).

Here is a reminder of the definitions of whey and curd available on the Engineer’s Techniques website:

Whey: Liquid co-product from cheese manufacturing, composed of 94% water, lactose, proteins soluble in the aqueous phase (serum proteins), higher or lower levels of minerale and lactic acid depending on the manufacturing technology.

Curd: Product obtained from the insolubilization of casein by the action of coagulating proteases (rennet for example) and/or by the action of acidification of milk.

Engineering techniques

Global migration tests:
They measure the overall quantity of substances that migrate from the plastic material into the curds and whey under predefined conditions of use.

Specific migration tests:
They consist of precisely searching for the quantity of a defined molecule which would migrate into the curds and whey under predefined conditions of use. The list of products to search for is present in the regulations: it is commonly called the "positive list".

2.2 MIGRATION TESTS

To perform global and specific migration tests, we must **define the test conditions:**

- Type of simulants
- Contact time and temperature

For this it is important to know the composition of the foodstuff (aqueous, fatty, acidic, etc.) and, in our case, its processing conditions.

THE CHOICE OF FOOD SIMULANTS

The various food simulants are listed in Table 1 of Annex III of Regulation (EU) 10/2011.

Table 1 *List of food simulants*

Food simulant	Abbreviation
10% ethanol (v/v)	Food simulant A
3% acetic acid (m/v)	Food simulant B
20% ethanol (v/v)	Food simulant C
50% ethanol (v/v)	Food simulant D1
Any vegetable oil containing less than 1% unsaponifiable matter	Food simulant D2
poly(2,6-diphenyl-p-phenylene) oxide, particle size 60-80 mesh, pore size 200nm	Food simulant E

To choose simulants, Annex III of the regulation constains a table for the choosing simulants according to the food products. In the "dairy products" category in column 07.04 is the "CHEESE" category.

Reference number	Description of food	Simulant					
		A	B	C	D1	D2	E
07.04	Cheeses						
	A. whole, with inedible rind						X
	B. natural cheese without rind or with edible rind (gouda, camembert and others) and fondant cheese					X/3(**)	
	C. processed cheese (soft cheese, cottage cheese and others)		X(*)		X		
	D. canned cheese						
	I. in an oily environment	X				X	
	II. in an oily environment		X(*)		X		

The regulation also provides for a combination of simulants allowing tests to be carried out to validate conformity for all types of food products.

Assignment of simulants for global migration tests

To demonstrate compliance with the overall migration limit for all types of foodstuffs, testing shoulg be carried out in distilled water or water of equivalent quality or in food simulants A and B and simulant D2

EU Regulation 10/2011

Food simulants A, B and C are assigned for foods that have a hydrophilic character and are able to extract hydrophilic substances. Food simulant B is used for those foods which have a pH below 4.5. Food simulant C shall be used for alcoholic foods with an alcohol content of up to 20 % and those foods which contain a relevant amount of organic ingredients that render the food more lipophilic.

Food simulants D1 and D2 are assigned for foods that have a lipophilic character and are able to extract lipophilic substances. Food simulant D1 shall be used for alcoholic foods with an alcohol content of above 20 % and for oil in water emulsions. Food simulant D2 shall be used for foods which contain free fats at the surface.

THE CHOICE OF TEST CONDITIONS

Standard conditions for global migration tests

Column 1	Column 2	Column 3
Test number	Contact time in days [d] or hours [h] at contact temperature [°C] for testing	Any food contact at frozen and refrigerated conditions.
OM2	10 days at 40°C	Any long term storage at room temperature or below, including when packaged under hot-fill conditions, and-or heating up to a temperature T where 70°C ≤ T ≤ 100°C for a maximum of t=120/2^[(T-70)/10]minutes.
OM3	2h at 40°C	Any food contact condition that include hot-fill and-or heating up to a temperature T where 70°C ≤ T ≤ 100°C for a maximum of t=120/2^[(T-70)/10] minutes, which are not followed by long-term room temperature or refrigerated storage.
OM4	1h at 100°C	High-temperature applications for all types of food at termerature up to 100°C
OM5	2h at 100°C or at reflux or alternatively 1h at 121°C	High temperature applications up to 121°C
OM6	4h at 100°C or at reflux	Any food contact conditions at a temperature exceeding 40°C, and with foods to which point 4 of Annex III assigns simulants A, B, C or D1
OM7	2h at 175°C	High-temperature application with fatty foods exceeding the conditions of OM5

Test MG7 also covers the contact conditions described for tests MG0, MG1, MG2, MG3, MG4 and MG5. They represent the worst case conditions for fatty food simulants in contact with non-polyolefinic materials. If it is technically impossible to carry out test MG7 with simulant D2, the test may be replaced by that described in section 3.2.

Test MG6 also includes the contact conditions described for tests MG0, MG1, MG2, MG3, MG4 and MG5. It represents the worst-case conditions for food simulants A, B and C in contact with polyolefin materials.

Test MG5 also includes the contact conditions described for tests MG0, MG1, MG2, MG3 and MG4. It represents the worst-case conditions for all simulants in contact with polyolefins. The MG2 test also covers contact conditions with polyolefins. Test MG2 also includes the contact conditions described for tests MG0, MG1 and MG3.

There are different ways to define test conditions for global and specific migration testing. However, they always depend on the conditions of contact with the food during use.

The table provided by the regulations (table 3 of annex 5) suggests contact conditions (duration and temperature) based on the contact conditions expected during use.

If none of the **conditions set out in the appendix take** account of the contact conditions under which the material is used, or if the conditions are too severe in relation to use, the operator may **carry out the tests under actual conditions of use. The producer is therefore responsible for the test conditions.**

There are a multitude of manufacturing conditions in a cheese factory such as the moulding temperature or the contact time between the mould and the curd of varying length. **The test conditions are therefore adapted, even personalised**, depending on the intended use in the cheese factory.

THE DECLARATION OF CONFORMITY CONCERNING MATERIALS IN CONTACT WITH FOOD

The **manufacturer of the material** is required to draw up a declaration of conformity concerning materials in contact with food products, commonly called a "**food certificate**". This declaration must include a number of details, in particular the conditions under which the **migration tests** were carried out. The list of information can be consulted in Annex 4 of Regulation (EU) No. 10/2011.

Emeline Du Fou, Sales Manager

"Servi Doryl offers its customers solutions adapted to various cheese-making techniques. **For example, for the manufacture of Paneer**, which requires moulding at very high temperatures, we have **adjusted the testing conditions.** The tests were carried out in an external laboratory by modifying the test parameters and optimising them. We have thus been able to guarantee that our moulds are suitable for food contact.»

ANIA, the French National food industry Association, has published a full model declaration and provides help on how to fill it in. This declaration is available to support manufacturers or users of materials coming into contact with food products but is not a mandatory document. The manufacturer can provide its own declaration, as long as it meets the expectations of the regulation. This is the case of Servi Doryl which provides its own declaration.

Clovis Dallais, Quality Manager

"As a quality manager moulds, I often have to respond to requests for migration tests or food safety certificates for **very old moulds**. I advise our customers on the regulations in force and explain that a certificate of conformity **is sufficient to comply with the regulations** and that they don't need to carry out migration tests. I then inform them of changes in the regulations over the years so that they understand that it is impossible to issue a certificate for their used moulds.»

François Raguin, Technical sales

"A cheese customer, using **straw draining mats**, asked us to offer him a **sustainable alternative for draining**. He wanted to eliminate the risk of contamination and extend the life of the equipment. In addition, we had to preserve the characteristic imprint left on the cheese in order to guarantee the good visual appearance of the final product. After an in-depth analysis of its historical trays, we proposed and prototyped flexible draining mats. The **food contact suitability tests have been adapted to simulate the specific use** of this customer. Following our discussions, tailor-made injection tools were designed for validation. The final blind, developed in close collaboration with our client, adapts perfectly to its cheese-making process, thus **guaranteeing a smooth technological transition as well as safety for the consumer**."

BEFORE

AFTER

3. REGULATIONS AND STANDARDS

3.1 DIFFERENCE BETWEEN REGULATION AND STANDARD

Regulation is the responsibility of public authorities.
It is the expression of a law, a regulation and its application is imposed.
Example: the Highway Code.

The standards are not mandatory, complying with them can ensure a level of control and may be requested by certain clients.
Example: ISO 9001

3.2 IFS AND BRC STANDARDS

The IFS & BRC standards are **audit standards** set up by large retailers in order to monitor the quality level of product manufacturers. Their objective is to provide healthy products to the consumer, to guarantee the safety of food to the distributor and to meet the requirements of Community hygiene regulations.

IFS :
The IFS Food standard (International Featured Standards) is an international standard for assessing the conformity of products and processes in terms of food safety and quality.

BRC Global Standards for Packaging:
The BRC (British Retail Consortium) standard is an international standard defining the safety, quality and production criteria required within a food production company to meet obligations in terms of compliance with legislation and protection of the consumer.

3.3 COMPARISON OF THE 3 EUROPEAN REGULATIONS

CONTEXT AND SCOPE

The idea is to **compare the three European regulations** (see part 1) which govern the suitability of plastic materials for food contact with the two main standards implemented in cheese factories (BRC and IFS). The comparison is made only on subjects that directly address the requirements and risks associated with materials and objects intended to come into contact with food.

COMPARISON

Standards always start with the commitment of the company's management, they require the **drafting of a policy followed by indicators and audit**. BRC certification requires the appointment of a BRC manager.
Regulation (EC) 2023/2006, for its part, only requires manufacturers to implement a **quality system** in its articles 5 and 7.
The quality system implemented according to regulation (EC) 2023/2006 integrates the notions of responsibility and document management. The standards specify that an **organisation chart of roles** and levels of responsibility must be provided as well as a clear and up-to-date **documentation system**.

Both standards specify that it is necessary to **establish a policy** proposing actions aimed at improving control of food and monitor their effectiveness with indicators. While the regulations do not specify anything on this subject.

Article 17 of **Regulation** 1935/2004 and the **standards agree on the obligation to put in place traceability** making it possible to control the withdrawal of products in the event of an alert and to be able to inform quickly in order to protect consumers. The **standards** add that written **procedures must be published.**

Regulation CE 2023/2006 requires the application of the **rules of good manufacturing practices** and the establishment of a corrective plan for hypothetical deviations; it does not specify the actions to be implemented but leaves it to the manufacturer to identify and apply them.

The standards detail, more precisely, the **actions to be implemented to comply with the regulations**, including aspects of **security**, employee **training**, and the **fight against pests and malicious acts**.

The various regulations do not address the risk analysis and the risk management, unlike the **standards** which impose a **detailed analysis approach such as a HACCP** (Hazard Analysis Critical Control Point) approach with associated procedures. The HACCP approach is a method created to detect all the dangers likely to appear during the storage, preparation or presentation of food.

As discussed in Chapter II, Regulation 10/2011 requires the drafting of a declaration of conformity concerning materials in contact with foodstuffs. In addition to meeting legal requirements for food contact, the standards add selection criteria for suitable materials (waterproof, stainless and designed to be easily cleaned - without dead zones).

3.4. COMPAREF®

COMPAREF® is a **tool for comparing quality standards and benchmarks** related to the production and evaluation of plastic materials, **developed by the technical center for plastics processing IPC (Innovation Plasturgie Composites).**

This tool allows you to **stay up to date on the latest quality norms and standards** in terms of packaged food safety to guarantee consumer protection.

It is possible to :

- Carry out **targeted searches** for easier navigation and understanding
- Find **summary presentations of requirements** according to quality criteria in the form of tables
- **Facilitate the interpretation** of requirements through comparisons
- **Choose the right standards** according to the uses and the actors in the sector

Only available in French at the moment.

COMPAREF®
LA SÉCURITÉ DES ALIMENTS EMBALLÉS PAR IPC

4. OUTSIDE EUROPE

Although **most countries outside Europe rely on the regulations cited in the first chapter, some of them have specific regulations and standards**. One example is the regulatory context in the United States, governed by the FDA (Food and Drug Administration).

For example, in government regulation (CFR) 21 “Food and Drugs,” the FDA provides certain specifications regarding the composition, additives, and properties that a material must meet to be declared FDA compliant. Plastic accessories intended for use in cheese making are covered by a particular paragraph 177 “Indirect food additives: polymers”. Each type of polymer is governed by a particular paragraph.

It is also interesting to make the link with the requirements of other standards (3A, USDA Guidelines for the sanitary design and manufacture of dairy processing equipment) presented earlier in this white paper.

CONCLUSION

In this first volume, we hope to have provided you with some keys to a better understanding of the fundamental properties of plastic as well as the technical and regulatory constraints linked to its use in the cheese manufacturing process.

The second volume of our series will look at essential aspects such as the choice of plastic materials for use in cheese factories, their durability and recycling.

If you have more specific questions, we will be happy to answer them.

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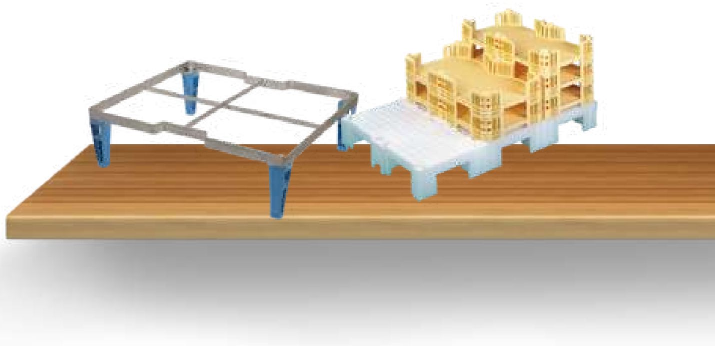
ABOUT SERVI DORYL

Since 1972, Servi Doryl has devoted itself exclusively to the design and manufacture of moulds and specific products for cheese making. It is by specialising in this way that Servi Doryl fully understands the constraints and requirements of its cheese customers, to provide adapted and innovative responses.

PRESSED CHEESE

AGEING SOLUTIONS



SOFT CHEESE

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