

Szent István Campus, Gödöllő Address: H-2100 Gödöllő, Páter Károly utca 1. Phone.: +36-28/522-000 Homepage: https://godollo.uni-mate.hu

THESIS

Yassine El Khourchi BSc in Mechanical Engineering

Gödöllő 2023

Hungarian University of Agriculture and Life Science Szent István Campus Bsc in Mechanical engineering

The use of purging compounds in extrusion

| Primary Supervisor: | Dobos József Internal thesis advisor : | |
|------------------------|--|--|
| Independent Consultant | | |
| Author: | Yassine El Khourchi SCAFW7 | |
| Institute/Department: | Mechanical engineering Technology | |

Gödöllő 2023



INSTITUTE OF TECHNOLOGY MECHANICAL ENGINEERING (BSC) Machine production technologies

THESIS

worksheet for

Yassine El Khourchi

BSc (full time student)

Entitled:

The use of purging compounds in extrusion

Task description:

In this thesis I will talk about purging compounds as a solution to the challenges facing extrusion equipment such as downtime and loss of productivity. I will delve into the importance of using purging compounds in the extrusion process, their benefits, and the different types of purging compounds available in the market. I will as well discuss best practices for selecting and using purging compounds to optimize production efficiency and maintain the quality of the final product.

Department: Mechanical Engineering technology

Consultant: Dobos József

Supervisor: Dobos József

Submission deadline: 03/05/2023.

Gödöllő, 20/01/2023.

| Approved | Received |
|---|-----------|
| Encer Ling | yoz |
| (head of department) (host course leader) | (student) |

As an independent consultant of the author of this thesis I hereby declare that the student took part in the planned consultations. Gödöllö, 02/05/2023.

Abstract :

This thesis investigates the use of purging compounds in extrusion processes to improve production efficiency and reduce material waste. The study explores the different types of purging compounds available and their properties, as well as the mechanisms by which they work to remove residual material from the extrusion machinery. The research also examines the factors that affect the performance of purging compounds, such as temperature, pressure, and residence time. The findings suggest that the use of purging compounds can significantly improve the efficiency of extrusion processes, but their effectiveness depends on several factors. The study concludes by providing recommendations for selecting the most appropriate purging compound based on the specific needs and conditions of a particular extrusion application.

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1. Introduction

Extrusion is a manufacturing method that involves pushing material through a die or orifice with a specific cross-sectional shape to produce objects with a fixed profile. This process employs compressive force to cause plastic deformation in the material. Numerous items are created through extrusion, such as :

- Pipes
- Window frames
- Shower stalls
- Windshield wipers
- Plastic bags...[1]

Extrusion is classified into several categories based on the primary materials used, including metal, plastic, and food.

To carry out the extrusion process, a machine called an extruder is used. The extruder machine heats up the material and moves it through the die to create the desired shape, using a system of barrels and cylinders. There are three kinds of extruders :

- Filament-fed extruders
- Screw extruders (typically fed by melted polymer pellets)
- Syringe extruders (typically filled with a hydrogel or polymer pellets).[2]



Figure 1. Plastic extrusion line.[3]

However, one of the challenges of extrusion is the buildup of residual material in the machinery, which can lead to defects, increased downtime, and material waste. To address this issue, purging compounds are commonly used to clean and maintain the extrusion machinery.

Purging compounds are chemical formulations designed to remove residual material from extrusion machinery, including polymers, colorants, and other contaminants. The compounds are used to purge the extruder, die, and downstream equipment, ensuring that the system is clean and ready for the next production run. Purging compounds work by melting, dissolving, or softening the residual material, which is then flushed out of the system with the purging compound.

While purging compounds are widely used in extrusion processes, the selection of the appropriate compound can be a complex task. There are many different types of purging compounds available, each with its own unique properties and mechanisms of action. Some compounds are designed to work at specific temperatures or pressures, while others are formulated to work with particular types of materials.[4]

The performance of purging compounds can also be affected by factors such as the residence time of the compound in the machinery, the type of extrusion equipment used, and the specific application. Therefore, selecting the most appropriate purging compound for a particular extrusion process requires careful consideration of these factors.[5]

This thesis aims to investigate the use of purging compounds in extrusion processes to improve production efficiency and reduce material waste. The study will explore different types of purging compounds available, their properties, and the mechanisms by which they work to remove residual material from the extrusion machinery. It will also examine the factors that affect the performance of purging compounds, such as temperature, pressure, and residence time. The findings of this study will provide valuable insights into the selection and optimization of purging compounds in extrusion processes, which can lead to improved efficiency and reduced waste.

1.1. The purpose of purging compounds

The purpose of purging compounds is to eliminate any residual materials or contaminants from the barrel, screw, nozzle, and mold or die of the machine to ensure that the resulting plastic parts are of high quality. For instance, If an extruder has just produced black parts and is now switching to white parts, the black plastic resin must be thoroughly cleaned out before white parts can be made. Similarly, when changing tooling or material, the previous material and any impurities must be purged from the system to produce satisfactory parts.[6]

1.2. Background of purging compounds for extrusion

For many years, thermoplastic extrusion has been a popular method for shaping plastic materials into continuous profiles of various shapes and qualities. However, changing materials has been a challenging task for molders, as it typically involves either opening the extruder or using a significant amount of plastic material to remove deposits of resins and other contaminants from the machine's barrel after extrusion.

Prior to the development of purging compounds, molders had to resort to manual cleaning or flushing the extruder with high molecular weight resins to remove contaminants. However, these methods were time-consuming and not effective in removing certain types of contaminants like carbon deposits and degraded residue from the barrel. Purge mixtures were therefore created to address these limitations and clean various types of contaminants that can occur during extrusion.[7]

1.3. Main aims of using purging compounds

Purge mixtures have an important function in efficiently and securely removing pollutants from extrusion machines, which results in a decrease in machine downtime and improving quality in production.

- The primary purpose of purging compounds is to remove any leftover plastic material between batches of resin. During the manufacturing process of thermoplastics, some of the resin may not pass through the entire process and can contain color and other properties that can affect subsequent batches of plastic parts. By using purging compounds, it is possible to produce clean articles without any discoloration or other properties from previous resin in just a few cycles.
- When you have a long production run with multiple batches of the same resin, you might need to use purging compounds to remove buildup of contaminants. Contaminants accumulate on the surfaces of thermoplastic machinery due to the chemical changes in plastic materials that do not fully pass through the system as it continues to heat up. Purging compounds can eliminate these deposits of contaminants, including carbon buildup, and also clean any plastic material. By keeping your processing surfaces free of contaminants, you can prevent black spots and other defects that result from the buildup of contaminants in your plastic parts.
- To prevent contamination, it may be necessary to remove any remaining resin or contaminants from the machinery before or after shutting down, depending on the machinery's operating specifications and the resin materials used. If residual plastic and contaminants are allowed to cool after machine operation, they can harden and become difficult to remove. Once they have hardened, removing them with purging compounds can become more challenging. Furthermore, the hardened contaminants can cause parts to have a reduced lifespan and may require disassembly and maintenance of the machinery for a thorough cleaning.[6]

1.4. Advantages of using purging compounds

Without a thorough purge between a color change and/or material change, defects such as black speaks or streaking will cause newly manufactured parts to be rejected. Reject parts and machine downtime add up to costly waste for the manufacturer. From the main advantages of using purging compounds, we can find :

- Ease of use

- **Cost savings,** Using purging compounds can be a cost-effective solution for businesses that currently use virgin resin or regrind to clear machinery. Although purging compounds may be more expensive per weight than virgin resin and sometimes even regrind, it is still a cost-saving option overall. When comparing the amount of virgin resin or regrind required, purging compound proves to be cost-effective. The real cost savings with purging compounds become evident when considering the cost of clearing contaminants. By running purging compound through your machinery, you can clear that would otherwise require disassembly and cleaning, which can be costly in terms of labor and machine downtime Furthermore, parts can last longer due to being more consistently cleaned, resulting in additional cost savings.

- **Cleaning efficacy,** Besides the benefits of cost and efficiency, purging compounds are also superior in terms of their ability to clean thermoplastic machinery compared to existing methods. While using virgin resin or regrind can gradually eliminate some of the remaining plastic material from the previous batch, it cannot effectively remove contaminants that accumulate over time. Moreover, using virgin resin or regrind only substitutes the existing material with remnants of the new batch. In contrasts, purging compounds can entirely clear plastic material and effectively remove contaminants rather than simply replacing the material with new remnants.
- **Increase machine uptime,** Purging compounds can decrease machine downtime significantly when compared to using virgin resin or regrind for cleaning purposes. The time required for effective cleaning is greatly reduced when using purging compounds, particularly for clearing out residual plastic material between batches. Although the exact timing may vary depending on machine capacity, material properties, processing temperature, and interval between cleanings, purging compounds typically takes between 5 and 15 minutes to clear plastic material and contaminant buildup. Moreover, purging compounds can minimize machine downtime by removing contaminants without disassembly and maintenance. Usually by using purging compounds the decrease in machine downtime is of 60%-80%.
- **Reduction of defective product,** Contaminants in thermoplastic machinery can pose risks to both the equipment and the plastic parts produced. While contamination can lead to black specks and streaks in plastic parts, it can also result in structural weaknesses due to uneven filling of mold cavities. These defects can be costly to test and repair. Using outdated methods to clear machinery of contaminants can lead to these defects being considered unavoidable. However, by using purging compounds regularly during long production runs and between batches of resin, defects can be significantly reduced.[6]

2. Literature review

2.1. Types of purging compounds

Numerous purging compounds are accessible commercially, but it's crucial to determine the appropriate one to utilize for eliminating a specific type of resin or contaminant. There are three main types of purging compounds :

- Mechanical purge
- Chemical purge[7]

2.1.1. Mechanical purge

Mechanical purging compounds use shear force as the primary method to eliminate contaminants from processing surfaces. Additionally, they can leverage variations in viscosity or bond with remaining resin and other contaminants to eliminate them for the surfaces being processed. Abrasive mechanical purging compounds are commonly available, but they can cause processing surfaces to wear out as a result of their cleaning action. However, purging compound's manufacturers are now offering non-abrasive mechanical purging compounds to provide cost-effective solutions. Although non-abrasive purging compounds cause processing surfaces to wear out, it is within the normal wear range that the machinery would experience during regular operation.

- The mechanical abrasive purging compounds are composed of low-viscosity abrasive minerals or glass-filled materials that can effectively remove resins from the extruder while simultaneously scrubbing and scouring the screw, barrel, and die. The cost of abrasive systems varies depending on the resin system and the filler used. For example, glass-filled polycarbonate (PC) is a suitable purging compound for cleaning polycarbonate or polyether amide from an extruder, but it can be expensive. Although cast acrylic is another material that can be used for making abrasive purging compounds, it does not completely melt in the extruder due to its high melt viscosity. Thus, it is recommended to remove the die prior to purging.
- Mechanical nonabrasive purging compounds use stiff materials, usually based on polyethylene (PE), which contain cleaning and release agents. High-density polyethylene (HDPE) with fractional melt flow is a commonly used mechanical nonabrasive purging compound due to its ability to function effectively over a wide temperature range.[7]

2.1.2. Chemical purge

Chemical purging compounds work by using chemicals that are activated by heat to break down the bonds between contaminants and processing surfaces. They typically require a short soaking time, usually between 5 to 30 minutes, to be effective. Unlike mechanical purging compounds, chemical purging compounds can be either solid or liquid. Chemical purging is a popular choice among molders because it has a high moldability rate and generates less scrap, which can be reused to produce parts. It is also faster and more efficient in removing residue due to the chemical reaction with resin and pigments, and requires only small quantities of purging material for a wide range of applications. While the use of commercial-grade chemical purging compounds can greatly reduce a company's production cost and ensure optimal machinery performance, it is susceptible to degradation and may not effectively remove carbon buildup in extruders. Additionally, the soaking time required during usage may lead to longer downtime and loss of productivity.[7]



Turbulent flow

Figure 2 : Material flow when using a purging compound.[8]

2.2. Consideration for choosing the right purging compound

When it comes to choosing a purging compound for extrusion, there are generally two main types to consider : mechanical and chemical. Mechanical purging compounds are great for quick- and easy color changes, as they work by increasing pressure in the barrel. For commodity resin types, these compounds can often provide a one-size-fits-all solution, particularly for injection molding applications where it is easy to increase pressure in the barrel.

On the other hand, chemical purging compounds work by using heat and containment, making them highly effective in low-pressure and low-flow environments, which can be challenging to clean. However, they do require a soak time to achieve optimal results, and selecting the right purging compound for these cases can be more demanding. That being said, they are often the best choice for hot runners and extrusion.

No matter which type of purging compound you choose, it is important to invest the necessary time in selecting the right one and following the appropriate instructions. This will be extremely beneficial in the long run.

When it comes to comparing the cost of a color/material change between these two types of compounds, it is essential to understand the differences in the purging procedures.

Using a mechanical purge to clean typically involves using one to two barrel capacities of the purging compound, followed by flushing with one barrel of virgin resin. The recommended procedure for the mechanical purging compound is two cycles.[6]

2.3. Extruder contaminants and their formation

The presence of contaminants during the extrusion process can lead to various quality issues and disruptions. Such contaminants can come in the form of solids, liquids, and gases, and are often deposited in the extrusion barrel. Some common contaminants include :

- Un-melted resin
- Degraded residue
- True gels
- Foreign contaminants
- Undispersed additives and modifiers
- Moisture
- Air bubbles or voids

2.3.1. Un-melted resin

Contamination and quality issues in the extrusion process are often caused by un-melted resin, which occurs when the extruder pumps the resin too quickly, resulting in solid or soft resin deposits in the barrel. Identifying and resolving un-melted resin can be challenging, but it can be detected by inspecting the extruded material for traces of previously extruded material. To address this type of contamination, the extruder should be slowed down until the issue is resolved, or denser screen packs can be added to increase back pressure and improve melting.[7]





Figure 3: screws containing un-melted resins before and after purging[9]

2.3.2. Degraded residue

Degraded residue is produced when the resin sits on process surfaces and degrades, causing it to contaminate the flow when it's released from the surface. Resins and additives can degrade during extrusion, resulting in the formation of carbon and other compounds. Carbon is produced when the resin is exposed to high processing temperatures in the presence of air for an extended period. These contaminants, which are formed in this way, can be removed using proper purge compounds and mechanical cleaning.[7]



Figure 4 : Screws containing degraded residue[7]

2.3.3. True gels

A true gel refers to a type of resin with an extremely high molecular weight, which may be cross-linked in a manner that causes it to have a very high viscosity and prevents it from dispersing into the melt stream.[7]



Figure 5 : screws containing un-dispersed gel before and after purging[7]

2.3.4. Foreign contaminants

Foreign contaminants refer to materials such as wood from pallets, paper, scrap plastics, dust, transfer pipe cross-contamination, and any other material that is not intended to be part of the material to be extruded but enters the extruder at any point during the extrusion process. These materials can be periodically detected using microscopes during production to examine the extruded resin for their presence.[7]

2.3.5. Un-dispersed additives

To incorporate additives into resins, they are usually added in the form of powder or master batch pellets that will melt and mix with the resin. However, when adding powdered additives directly to the resin in the extruder, they can clump together due to the high pressure, making it difficult to break them down. This can lead to the formation of white or colored contaminants in the extruded product.[7]



Figure 6 : Screw contaminated with un-dispersed contaminants[7]

2.3.6. Moisture

Moisture is a prevalent cause of defects in materials post-extrusion. While some resins can tolerate higher moisture levels, provided the extruder is vented, each resin reacts uniquely to moisture. For instance, some resins undergo degradation when exposed to moisture, resulting in low viscosity melt. On the other hand, other resins may produce bubbles, thereby affecting the molding process.[7]

2.4. Commercial purging compounds applications

Purging compounds that are designed for commercial use are readily accessible and can be used to clean and remove residual materials from commonly processed resins, including commodity materials like acrylic, polypropylene, polyethylene, polystyrene, and polyvinyl chloride, and also engineering resins like ABS, polycarbonate, PET, PBT, nylon, TPO, TPE, and many others.

Commercial purging compounds are used to clean various components of thermoplastic processing equipment such as nozzles, screws, barrels, and extrusion dies. Some CPCs are also designed to clean hot runner systems or manifolds. Regular use of quality commercial purging compound can eliminate the need for manual screw cleaning. If manual cleaning is still required, using a high-quality purging compound before pulling the screw can make the process easier.

Additionally, many commercial purging compounds are recommended for use before and/or after machine shutdown to prevent contamination during machine cool down, leading to improved startup and reduced waste.[4]

2.5. An example of a mechanical commercial purging compound

2.5.1. Product description

PurgexTM 456 Plus is a type of commercial purging compound that is already prepared and contains active components mixed with polyethylene carrier. These types of purging compounds have mechanical properties that help with effective cleaning, foaming abilities that improve mixing, and a lubricant that simplifies removal. They are also useful for preventing color mixing during the process of changing colors.[10]



Figure 7 : Purgex commercial purging compound.[11]

2.5.2. Purging compound properties

- A mixture of active components and polyethylene : The active components can include surfactants, lubricants, and solvents... Which work together with the polyethylene to effectively remove residual materials from the extrusion machinery. The active components are responsible for breaking down and dissolving the residue, while the polyethylene serves as a carrier material, allowing the purging compound to flow through the system and reach all areas in need of cleaning.
- Safe, non-toxic and non-abrasive : These characteristics ensure that the purging compound does not pose any harm to the operators, the equipment, or the environment. Being safe means that it does not contain hazardous chemicals or substances that could endanger human health. Being non-toxic ensures that it does not release harmful fumes or residues during use. Lastly, being non-abrasive means that it does not cause damage or wear to the surfaces of the extrusion machinery.
- Can be removed with ease : Can be removed using minimal effort and time. This means that it does not require excessive flushing or cleaning cycles.[11]

2.5.3. Solution for color changes

PurgexTM 456 plus was designed specifically for facilitating efficient and effective color changes. The product provides a range of features and advantages for cleaning extruders. The following are all the features and benefits of the product :

- Designed for color and/or material changes on many different resins plus efficient cleaning of hot runner systems, PurgexTM 456 plus has proven versatility on a wide range of resins such as HDPE, LDPE and PP-Copolymer.
- Engineered for rapid turnaround on material and color changes. Efficiently removes residual contamination.
- Effectively cleans the barrel, screw, check ring, as well as hot runner systems and is safely processed through hot runner gates as small as 0.75mm.
- Through cleaning of melt pumps and is safely processed through dies as small as 0.75 mm.
- Active components in PurgexTM 456 Plus neutralize acid gases generated by PVC.
- With regular use, the product forms a temporary barrier that protects steel surfaces from oxidation, extending the cleaning process.[10]

2.5.4. Advantages of the product

- More affordable.
- Versatile in terms of properties and uses.
- Density of the purging compound is suitable.
- Resistant to various chemicals.
- Minimal moisture absorption.
- High resistance to chemicals.
- Suitable for packaging applications.
- Optimal processing temperature.[10]

2.5.5. Disadvantages of the product

- Shows a significant thermal expansion.
- Demonstrates low stiffness when using standard grades.
- Exhibits poor resistance to UV rays.
- Has low resistance to oxidation.
- Unlike PP, it does not have transparency.[11]

2.6. NCR Grade as an example of a chemical commercial purging compound

NCR Grade is a brand name of a chemical purging compound that is highly adaptable and efficient, particularly for color and material changes in thermoplastic injection molding and extrusion machinery. This product has a broad service temperature range that covers most commodity and engineering-grade resins processed up to 345°C, making it unnecessary to store several grades of purging compound.[12]



Figure 8 : NCR Grade purging compound product.[12]

2.6.1. Features of NCR Grade

- NCR Grade is considered by many as the top chemical purging compound available. It performs exceptionally well in low flow/low pressure environments such as extrusion and hot runners, and it provides powerful cleaning without leaving any residue.
- NCR Grade has the ability to purge a variety of production resins at a wide processing temperature range. It efficiently eliminates contamination, simplifies the changeover process, and can be easily displaced by the next resin.[12]

2.6.2. Benefits of NCR Grade

- High-performing, multipurpose grade.
- Created for color and material transitions.
- Provides powerful cleaning for extrusion processes.
- Particularly suitable for low flow or low pressure environments that require foaming action.
- Activated by heat.
- Based on polyethylene.
- Efficient for preventing buildup during shutdown and sealing.
- A short soak time is enough for optimal results.[13]

2.6.3. Usage information for NCR Grade

| Temperature range | 175°C to 360°C |
|-------------------|--|
| | No minimum hot runner gate clearance |
| Minimum clearance | requirement nor extrusion die or mesh |
| | clearance requirement. |
| | Typically 1-2 system capacities (actual |
| Amount of purge | amount depends on degree of |
| | contamination). |
| | Extrusion (profile, sheet, cast film and |
| Applications | compounding). |
| | Injection molding (including hot |
| | runners). |
| | Most commodity and engineering |
| Types of resin | grade resins within the processing |
| | temperature range. |

 Table 1 : Usage information for NCR Grade[12]

2.6.4. Properties of NCR Grade

| Physical form | Solid. | |
|--------------------------|-------------------------------------|--|
| Shape | Pellets. | |
| Color | Transparency and white are mixed. | |
| Water solubility | Insoluble. | |
| Other solvent solubility | Insoluble for organic solvent under | |
| | normal temperature. | |
| Stability | Stable under normal temperatures. | |
| Reactivity | Non-reactive under normal handling | |
| | and storage conditions. | |

Table 2 : Properties of NCR Grade[12]

2.7. Case study 1: Recommendations of purging compounds

This study shows a recommendation of purging compound to each of the two companies (company 1 and company 2) depending on their type of extrusion and resin types. Company 1 uses sheet extrusion, while company 2 uses blown film extrusion.[14]

2.7.1. Recommendation of a purging compound to a company using sheet extrusion

This HDPE sheet extruder faced minimal issues with resin changes and machine shutdowns, but switching colors was causing significant problems that sometimes took hours or even days to resolve.[14]

Sheet extrusion is a method that creates flat plastic sheets from various resins. The produced sheets have various applications such as packaging, including deli containers and baby wipe containers, as well as industrial purposes, such as boat building. Geomembranes are also created from extruded sheets by welding them together to form containment systems that are used in mining and municipal waste management.[15]



Figure 9 : Sheet extruder[16]

Sheet extrusion refers to a process where the width of the die exit is greater than its height. Due to the requirement to melt all the material and the high flow through the die, this process is slower compared to tube extrusion. In fact, the production speeds are often much slower and can be up to 10 times lower. The typical production speed ranges around 0.05 m/s, but this can vary depending on the specific material properties and equipment being used.[16]

Given the low melt index of the HDPE, the selected purging compound was NCT ASACLEAN as a chemical purge.

ASACLEAN NCT is a chemical purging compound that is suitable for color and material changes and is ideal for high-temperature resins. It is made of polyethylene (PE) and is perfect for purging moderate viscosity resins. This compound can also be used for sealing and shutting down machines to prevent carbon buildup on start-ups. ASACLEAN NCT is effective for use in low pressure or low flow environments where foaming action is critical and can withstand higher processing temperatures. Additionally, it is insoluble in water and well-suited for use in thermoplastic injection molding and extrusion machines.[19]

Here we can find some benefits of the ASACLEAN NCT product :

- Suitable for blow molding applications.
- Specially formulated for changing colors and materials.
- Particularly useful 7in low flow or low pressure environments where foaming can be problematic.
- Minimizes foaming even in high-temperature environments where foaming can be problematic.
- Minimizes foaming even in high-temperature environments.
- A chemical purging compound based on polyethylene.
- Effective for machine shutdown and sealing to prevent buildup.
- Offers maximum effectiveness with a brief soak.[19]

We can see in the table below some properties of the ASACLEAN NCT product :

| Temperature range | 175°C to 360°C |
|-------------------|------------------------------------|
| | Most engineering resins within the |
| Type of resin | processing temperature range above |
| | 175°C |
| Melting point | >120°C |
| | |

Table 3 : Properties of the ASACLEAN NCT product[19]

2.7.2. Recommendation of a purging compound to a company using blown film extrusion

When this blown film producer was using LDPE, the machine was experiencing black specks due to oxidation in the barrel which led to a lot of scrap at start-up.[14]

Blown film extrusion is the predominant method used to produce continuous films that are primarily used in packaging. To begin the process, the plastic is melted in the extruder and then sent through an annular die head where it forms a tube of plastic material. If multiple layers are needed, a separate extruder is required for each material, and the melted strands are combined in the die head to create a tube with concentric layers. The film tube, still in a plastic state, is then pulled up by nip rollers while compressed air is blown into it to achieve the desired thickness and width. Chilled air is blown on the outside of the tube to cool it down, and once cooled, the film is flattened into 'lay-flat' tubing by the nip rollers. The finished film is then transported to the in-line slitters and roll winders located at the bottom of the production line.[18]



The best solution for cleaning this LDPE blown film extruder was the UF2 ASACLEAN purge.

The UF2 Grade purging compound is a highly effective and versatile solution specifically designed for use in changing colors and materials in thermoplastic injection molding, extrusion molding, and blown film extrusion machines.[17]



Figure 11 : UF2 ASACLEAN product[17]

We can find below some features of the UF2 ASACLEAN product :

- UF2 is highly compatible with PE resins, making it a reliable choice for processors who require consistent color and material changes.
- It is a safe and efficient option for purging dies and hot runners, especially in sheet and blown film extrusion. UF2 can maintain a bubble in film and swiftly clear the edges of dies in sheet extrusion. Moreover, it is a preferred purging compound for hot runners due to its reliable cleaning power, regardless of gate sizes.[17]

Here are some benefits of using the UF2 ASACLEAN product :

- Compatible with blown and cast film extrusion processes.
- Can be used to purge without removing the die.
- Works well with PE resins.
- Effectively removes non-carbonized gels and contamination.
- Suitable for cleaning during color or material changes for polyethylene.
- Can maintain the shape of the bubble in blown-film extrusion.
- Does not cause any chemical reaction.
- Does not require any soaking time.[17]

UF2 ASACLEAN can be wildly applied, we can fin below some of its main application :

- Transitions between colors.
- Transitions between materials.
- Machine shutdown and sealing.
- Cleaning of hot runners.
- Purging to prevent contamination buildup.[17]

The table below shows the usage information of the UF2 ASACLEAN product :

| Temperature range | 170°C to 320°C |
|-------------------|--------------------------------------|
| Minimum clearance | Requires 0.01 mm clearance for hot |
| | runner gates and extrusion dies; |
| | 200-mesh is required for extrusion |
| | screen packs when only 1 layer of |
| | mesh is used. |
| Amount of purge | Typically 1-2 system capacities |
| | (actual amount depends on degree of |
| | contamination). |
| | Injection molding (including hot |
| Applications | runners). |
| | Extrusion (Profile, sheet, cast film |
| | and compounding). |
| | Purging to and from polyethylene- |
| Type of resin | based resins within the processing |
| | temperature range. |

Table 4 : Usage information of UF2 ASACLEAN[17]

Some of the UF2 ASACLEAN product's properties are summarized in the table below :

| Physical form | Solid | |
|--------------------------|-------------------------------------|--|
| Shape | Pellets | |
| Color | Transparency and white are mixed | |
| Water solubility | Insoluble | |
| Other solvent solubility | Insoluble for organic solvent under | |
| | normal temperature | |
| Stability | Stable under normal temperatures | |
| Reactivity | Non-reactive under normal handling | |
| | and storage conditions | |
| | Do not exceed recommended | |
| | temperature range. | |
| Conditions to avoid | Do not allow UF2 Grade to reside in | |
| | barrel for more than 30 minutes at | |
| | temperatures higher than 280°C. | |

Table 5 : Properties of UF2 ASACLEAN[17]

And here we can find some measurements of the UF2 ASACLEAN product :

| Specific Gravity | 0.95 at 23°C |
|--------------------------|----------------|
| Softening Point | 130°C to 135°C |
| Flashpoint | 380°C |
| Autoignition Temperature | 400°C |
| | |

Table 6 : Measurements of UF2 ASACLEAN[17]

2.8. Laboratory made purging mixtures

As indicated below five different samples of the purging mixture named A,B,C,D, and E. Each sample consisted of the base resin, SiO2, and green clay were tested in a laboratory.

| Specimen | Recycled | Silicon | Green clay (%) |
|----------|----------|------------|----------------|
| | HDPE(%) | dioxide(%) | |
| Α | 90.9 | 7.3 | 1.8 |
| В | 83.3 | 12.5 | 4.2 |
| С | 71.4 | 14.3 | 14.3 |
| D | 90.9 | 4.5 | 4.5 |
| Ε | 87.0 | 4.3 | 8.7 |

Table 7 : constituents of the purging mixtures[7]



Figure 12 : The recycled HDPE used for the purge mixture[7]

To guarantee a secure and accurate production of the purging compound- in a laboratory, the following measures should be observed during the process :

- Make sure the clay is completely dry before using it.
- Certain colorants and additives may interact with the mixture and generate harmful gases, Should be tested for reactions with clay and silicon dioxide before use.
- Ensure that the plastic resins are dry before extrusion to prevent deterioration of the purge mixture.

- Wear a respiratory mask while handling silicon dioxide, as its particle size is easily inhaled and hazardous
- Mix the purge at low speeds to ensure uniformity.

Creating a personal purge mixture may pose a challenge due to the required equipment and reagents, but it is a cheaper alternative to purchasing a commercial purge compound. The basic components of a purge, such as clay and silicon dioxide, are inexpensive, and recycled HDPE is readily available. The cost of the production cost of a 25Kg mixture is approximately 1.29ε . This estimate only considers the cost of raw materials, including $12.71\varepsilon/200g$ of green clay, $0.44\varepsilon/kg$ of silicon dioxide, and $1.12\varepsilon/metric$ ton of recycled HDPE.

Along with other costs related to materials and production, the purge mixture is less expensive than the commercial purge compound.[7]

3. Material and method

In this part of the I will make a comparison between two purging compounds, the RAMCLEAN 101 and the ULTAPURGE 1220.

3.1. Ramclean 101

RAMCLEAN 101 is a type of purging compound used in extrusion processes to effectively clean and maintain the extrusion machinery. It is a proprietary blend of active components and polyethylene that is specifically formulated to remove residual materials, such as colorants and additives, from the extrusion system.

RAMCLEAN 101 is known for its high cleaning efficiency and can be used with a wide range of thermoplastic resins, including polyolefins, polycarbonates, and PVC. It is also safe, non-toxic, and non-abrasive, ensuring that it does not pose any harm to the operators, the equipment, or the environment.

The RAMCLEAN 101 purging compound is easy to prepare and can be removed with ease, using minimal effort and time. It is recommended for use in hot runner systems, injection molding machine, and extruders, and can be used for both color and material changes.

RAMCLEAN 101 is a reliable solution for maintaining the quality and efficiency of the extrusion process, reducing downtime, and increasing productivity.

We can find below some advantages of the RAMCLEAN 101 product :

- Does not require any additional material or substance (such as resin) to be used : One of the key features of this purging compound is that it does not require any additional material or substance to be used alongside it during the cleaning process. RAMCLEAN 101 is designed to work effectively on its own, without the need for any additional resin or cleaning agents to be mixed in. This simplifies the cleaning process and reduces the amount of material and resources required for maintenance, making it a more cost-effective solution. Additionally, not requiring any additional materials also ensures that the purging compound does not have any adverse effects on the final product or the extrusion equipment.
- Effective in cleaning when the proper washing procedure is followed : The manufacturer's recommended procedure typically involves heating the extruder to a specific temperature, introducing the purging compound, allowing it to soak for a certain period of time, and then purging it out with virgin resin. If the proper procedure is followed, RAMCLEAN 101 can effectively remove residual material and contaminants from the extrusion machinery, improving efficiency and reducing waste.

- Provides a favorable price-to-value ratio : One of the benefits of RAMCLEAN 101 is that it provides a favorable price-to-value ratio. While it may not be the cheapest purging compound on the market, it offers a good balance between price and performance, providing high-quality cleaning results for an affordable price. This makes it a cost-effective solution for extrusion processes that require regular maintenance and cleaning. By using a purging compound that provides a favorable price-to-value ratio, manufacturers can save money on maintenance and reduce the risk of production delays caused by machinery downtime or poor quality output.
- Can be utilized for machine shutdown purposes : This purging compound can be utilized for machine shutdown purposes, making it a versatile and useful solution for extrusion processes. When machines need to be shut down for maintenance, it is important to thoroughly clean them to prevent residual material from hardening and causing problems when production resumes. RAMCLEAN 101 can be used to effectively purge the machine of residual material and prepare it for shutdown. This helps to ensure that the machinery is properly cleaned and ready for use when production resumes, reducing the risk of problems and delays. By utilizing a purging compound that can be used for machine shutdown purposes, manufacturers can improve the efficiency and reliability of their extrusion processes.

RAMCLEAN 101 has also some disadvantages, from which we can find :

- Can only be used at a temperature higher than 240°C : This purging compound can only be used at a temperature higher than 240°C. At lower temperatures, the purging compound may not be effective in removing residual material from the machinery, leading to poor quality output and potential production issues.
- Batch washing is time-consuming : Involves manually cleaning the extrusion machinery. It requires halting production and dedicating personnel and resources to the cleaning process, which can result in decreased production efficiency and increased costs.
- Requires higher cylinder and throttle settings : When using RAMCLEAN 101 it may be necessary to adjust the cylinder and throttle settings on the extrusion machinery to achieve optimal results. Specifically, higher cylinder and throttle settings may be required to effectively remove residual material from the machinery. However, it is important to note that these adjustments should be made carefully, as improper settings can result in equipment damage or decreased production efficiency.

- Removing the purging compound from the cylinder is challenging : After using a purging compound in an extrusion process, it is important to thoroughly remove the compound from the cylinder to prevent potential equipment damage or contamination of subsequent production runs. However, this can be a challenging process, as RAMCLEAN 101 is designed to adhere to the surfaces of the machinery and may require special cleaning procedures to remove completely. It is important to follow proper cleaning procedures to ensure that the purging compound is fully removed from the machinery and that subsequent runs are not affected. This can involve the use of specialized cleaning agents or procedures, which may require additional time and resources. However, proper cleaning is essential to ensure the long-term functionality and efficiency of the extrusion process.
- Incompatible with hot runners : RAMCLEAN 101 cannot be used to clean the hot runner system of the extrusion machinery. Hot runners are particularly challenging to clean due to their complex design, and a purging compound that is not specifically designed for this purpose may not effectively remove all the residual material. This can result in contamination of the next production run, leading to defects and wasted material.
- When changing color, ABS requires heating : When changing color during an extrusion process involving ABS, heating is necessary. ABS, or acrylonitrilebutadiene-styrene, is a thermoplastic polymer that requires a specific temperature range to reach its melting point and become extrudable. Therefore, when changing the color of ABS, the material needs to be heated to the appropriate temperature range to allow for proper melting and extrusion of the new color. This heating process can be done using external heaters or by increasing the temperature of the extrusion barrel itself. Proper heating is important to ensure a consistent and high-quality output of the final product.
- POM always requires re-cooling : When using a purging compound for POM (polyoxymethylene), it is important to note that the material always required recooling after purging. This is because POM has high crystallization rate, and if it is not cooled properly, it can cause issues with the next batch of material being processed. RAMCLEAN 101can effectively remove any residual POM from the machinery, but re-cooling is necessary to ensure proper processing conditions.

The general purpose of RAMCLEAN 101 can be summarized in the following :

- This is a versatile chemical purging compound suitable for various applications : RAMCLEAN 101 is capable of serving multiple purposes across a range of application. It implies that the compound can be used for different types of extrusion machinery and plastic materials. It also has a broad range of capabilities and can be used in different scenarios, making it a potentially valuable tool in the manufacturing process.

- Produces moderate foaming during use : RAMCLEAN 101 generates a certain level of foam during its use. The amount of foaming can vary depending on the specific compound and the application in which it is being used. While some foaming can be beneficial in certain applications, too much foaming can lead to issues such as reduced efficiency, poor cleaning results, and longer downtime for cleaning. Therefore, it is important to choose a purging compound that produces an appropriate level of foam for the intended use.
- Formulated to effectively clean a wide range of materials including PP, PE, ABS, ASA, EVOH, POM copolymer, among others.
- Recommended for use in temperature ranging from 150°C-250°C.
- Suitable for both extrusion and injection processes (open mold).[21]

3.2. Ultra purge 1220

Ultra Purge 1220 is a chemical purging compound that is designed for use in injection molding machines and extruders. It is formulated to clean thermoplastic materials such as polypropylene, polyethylene, and polystyrene. This purging compound is also effective for use with some engineering resins like ABS, PC, and PVC.

Ultra purge 1220 is a non-abrasive, non-toxic, and non-flammable compound that can be used at temperatures ranging from 190°C to 320°C. It is designed to help reduce downtime during color and material changes by effectively cleaning the machine barrel, screw, and hot runner system.

Ultra purge 1220 can be used in both hot and cold runner systems, and its low residue formulation makes it easy to clean and remove from the machine.

We can find below some advantages of using Ultra purge 1220 :

- No gas, no rumbling, no smoke : Ultra purge 1220 is effective at cleaning and clearing out any residue or impurities from a processing machine without creating any additional environmental concerns or safety hazards that could arise from gas, rumbling or smoke.
- Has food industry certification : Ultra purge 1220 has been evaluated and deemed safe for use in food processing and packaging equipment. Certification is an important requirement in the food industry to ensure that products and processes adhere to strict safety and quality standards. Therefore, the fact that Ultra purge 1220 has obtained food industry certification indicates that it has met the necessary criteria and can be used with confidence in food-related applications.

- Wide heat range (160°C-250°C) : Ultra purge 1220 can be used to clean processing equipment and molds that operate within this temperature range without experiencing degradation or breakdown. The wide heat range also makes the compound versatile and useful for a variety of applications, as many processing machines and equipment operate within this temperature range. Therefore, the Ultra purge 1220's wide heat range makes it a suitable purging compound for a broad range of industrial applications.
- Can be used to stop the machine : The compound can be used as an emergency stop or shutdown solution in situations where immediate machine stoppage is required. This feature is especially useful in cases where a machine is malfunctioning or producing defective products, as using the purging compound can quickly clear out any impurities or residue that may be causing the issue. Additionally, the ability to use the Ultra purge 1220 to stop the machine can help prevent further damage to the equipment and reduce the risk of accidents or injuries in the workplace. Therefore, this feature adds an extra level of safety and convenience for industrial operators who use the Ultra purge 1220 purging compound.
- No machine adjustment required : Ultra Purge 1220 purging compound does not require any machine adjustments to be made during its use. This means that the compound can be used as a drop-in solution without requiring any additional equipment or modifications to the processing machine. The ability to use the purging compound without any adjustments makes it a convenient and cost-effective solution for industrial operators, as it saves time and money that would otherwise be spent on equipment modifications or additional tools. Furthermore, the lack of required machine adjustments also reduces the potential for operator error, as there is no need to make adjustments that could lead to further problems or issues. Overall, this feature makes the Ultra purge 1220 an easy-to-use and accessible solution for industrial cleaning and purging applications.
- Purging compound is easily removed from the cylinder, resulting in minimal waste : Ultra purge 1220 can be efficiently cleaned out of the cylinder without leaving behind any significant residue or waste material. The ability to easily remove the purging compound from the cylinder is a desirable feature in industrial applications, as it helps reduce downtime and increase production efficiency. Additionally, the minimal waste generated from the purging process is beneficial for environmental reasons, as it reduces the amount of waste material that needs to be disposed of or recycled. Overall, this feature of the Ultra purge 1220 purging compound helps make it a cost-effective and environmentally friendly solution for industrial cleaning and purging applications.
- Excellent for hot runners cleaning : Ultra purge 1220 is designed to effectively clean hot runners by removing any impurities or residual material that may be causing clogs or defects in the finished product. Its wide temperature range makes it suitable for use with hot runners, which typically operate at high temperatures. The purging compound can effectively clean hot runners without causing any damage or degradation to the system, which is important for maintaining production efficiency and preventing downtime.

- No heating required when changing ABS color : When switching between colors of ABS (Acrylonitrile Butadiene Styrene) plastic, residual material from the previous color can cause discoloration and other defects in the new product. The purging compound is designed to effectively remove any residual material from the processing machine, allowing for a clean transition to the new color. The fact that no additional heating is required is an important benefit, as heating can be time consuming and may delay production. Additionally, excessive heating can cause damage to the processing machine or the plastic material itself, leading to additional costs and production delays. The ability to change ABS colors without requiring additional heating can help save time and money, while also improving overall production efficiency.
- POM color change does not require cooling : When changing colors of POM (polyoxymethylene), residual material from the previous color can cause discoloration and other defects in the new product. The purging compound is designed to effectively remove any residual material from the processing machine, allowing for a clean transition to the new color. The fact that cooling is not required is an important benefit, as cooling can be time consuming and may delay production. In conclusion, Ultra purge 1220 purging compound is a useful solution for changing colors of POM plastic, as it effectively removes residual material without requiring cooling. This feature helps improve production efficiency and reduce the potential for defects or quality issues in the finished product.
- The most improved cleaner in the world for the last 3 years : Being recognized as the most improved cleaner in the world for 3 years is a significant achievement, as it demonstrates a sustained commitment to innovation and improvement. The fact that Ultra purge 1220 has been recognized as the most improved cleaner in the world for the last 3 years is a testament to its effectiveness and ongoing commitment to innovation. This can give users confidence in the product's ability to help improve production efficiency, reduce waste, and maintain high product quality.

Ultra purge 1220 has also some disadvantages from which we can site :

- It seems more expensive at first sight, but there are significant differences in efficiency (time, quantity of rejects, use...) : The disadvantage here is the pricing of the product, it may seem very expensive. But while the upfront cost of the purging compound may be higher than other solutions, the long-term benefits may outweigh this cost. Additionally, if the purging compound can help improve production efficiency by reducing downtime and increasing output, this can also contribute to overall cost savings. To conclude, Ultra purge 1220 may appear more expensive at first, but its efficiency and long-term benefits make it a cost-effective solution for plastics processing.

Overall, Ultra Purge 1220 is a purge compound that comes ready to use and contains Ultra-X technology, making it appropriate for both injection molding and extrusion lines. It is comprised of superior quality thermoplastic polymers, along with powerful cleaning agents. And have important benefits such as :

- Easy to use.
- High efficiency.
- Rapid cleaning effect.
- Wide range of applications.

4. Results

In this study we will calculate the cost effectiveness and time processing of two commercial purging compounds, Ultra Purge 1220 and Ramclean 101.

| City | Kecskemét, Hungary | |
|----------------------|-----------------------------------|--|
| Company | Phoenix Mecano | |
| Purpose of the study | Color change black to green (PBT- | |
| | POM) | |
| Screw diameter | 50 mm | |
| Machine type | E150/3 | |
| Date | 2023/03/03 | |

The details of the test are shown in the table below :

Table 8 : details of the test

On March 3rd, 2023, a test was conducted in Kecskemét (Hungary) to compare the performance of the Ultra purge 1220 and Ramclean 101 purging compounds. The study was managed by Phoenix Mecano, a company that specializes in plastic processing technology. The goal of the test was to evaluate the efficiency and effectiveness of the two purging compounds for a color change from black to green on a machine with 50 mm screw diameter, specifically the E150/3 machine time. PBT-POM was the material used for color change. This study aimed to provide insights into the performance of these two purging compounds, allowing manufacturers to make informed decisions on which purging compound would best meet their production needs. The results of the test could help manufacturers to improve efficiency, reduce waste and downtime, and maintain product quality during color changes.

4.1. Testing process

The table below shows the time processing of the Ramclean 101 and Ultra purge 1220 testing :

| Process | Time |
|--|----------|
| 1- Heating to 260°C | 00:08:00 |
| 2- Injection of purging compound + waiting time of 3 repetitions | 00:15:36 |
| 3- Inflow of green material and partial cleaning | 00:20:05 |
| 4- Cooling down | 00:32:30 |
| 5- Start | 00:42:40 |

Table 9 : Processing time of Ramclean 101 and Ultra purge 1220 testing

The table above presents a breakdown of the time required for different steps in the Ramclean 101 purging compound testing. The process consisted of five steps, which are heating, injection of purging compound, waiting time, inflow of green material and partial cleaning, and cooling down. The table shows the time required for each step.

- The first step is heating to 260°C, which takes 8 minutes. This step involves raising the temperature of the machine to the desired level for processing plastic.

- The second step is injection of purging compound, which takes 15 minutes and 36 seconds. This step involves injection the purging compounds into the machine to clean the system.
- The third step is inflow of green material and partial cleaning, which takes 20 minutes and 5 seconds. This step involves introducing the new material into the system and cleaning out any remaining residue from the purging compounds.
- The fourth step is cooling down, which takes 32 minutes and 30 seconds. This step involves lowering the temperature of the machine to a safe level before continuing with production.
- Finally, the fifth step is start, which takes place at 42 minutes and 40 seconds. This step represents the start of production with the new material, once the machine has been cleaned and cooled down.

| - | Time/weight | Price | Amount | |
|-----------------|-------------|--------|----------|--------|
| | | | | |
| Purging | 905g | 5.30€ | 4.7965 € | - |
| compound with | _ | | | |
| black | | | | |
| Green material | 1325g | 4.60€ | 6.095€ | |
| mixed with | | | | |
| purging | | | | |
| compound | | | | |
| Weight of scrap | 1780g | 4.60 € | 8.188 € | |
| pieces (10 pcs) | | | | |
| Machine hourly | 00:42:40 | 5.00 € | 3.55 € | |
| rate | | | | |
| Personal hourly | 00:42:40 | 15.30€ | 10.88€ | |
| fee | | | | |
| Total | - | - | - | 33.509 |
| | | | | € |

4.2. Ramclean 101 testing results

Table 10 : Ramclean 101 testing results

The table above provides information on the cost of using Ramclean 101 purging compound for a color change process. The table indicates that 905g of purging compound with black was used, which costs 5.30, resulting in a total cost of 4.7965. The green material mixed with purging compound weighed 1325g, costing 4.60, and amounted to 6.095. The weight of scrap pieces was 1780g, and it cost 4.60, resulting in a total cost of 8.188. The machine hourly rate was 5.00 for a total of 00:42:40, which is equivalent to 3.55. The personal hourly fee was 15.30 for a total of 00:42:40, which is equivalent to 10.88. Therefore, the total cost of the process was 33.5095. The table indicates the different cost components of the color change process, which can be used to calculate the overall cost and optimize the process to reduce costs.

4.3. Ultra purge 1220 testing results

| - | Time/weight | Price | Amount |
|-----------------|-------------|---------|----------|
| Ultra purge | 1077g | 10€ | 11.3€ |
| purging | | | |
| compound | | | |
| Purging | 372g | 3.90€ | 4.18€ |
| compound with | | | |
| black | | | |
| Scrap pieces | 534g | 4.60€ | 2.477€ |
| (3pcs) | | | |
| Machine hourly | 00:13:25 | 5.00€ | 1.117€ |
| charge | | | |
| Personal hourly | 00:15:45 | 15.30 € | 3.83€ |
| fee | | | |
| Total | - | - | 22.904 € |

Table 11 : Ultra purge 1220 testing results

The table above provides a cost analysis for using Ultra purge 1220 as the purging compound. The total amount of the purging compound used was 1077g, which cost $10 \in$. In addition, 372g of the black purging compound was used, which cost $3.90 \in$. The weight of the scrap pieces was 534g, and the hourly charge for the machine was 00:13:25, costing $5.00 \in$. The personal hourly fee was 00:15:45, costing $15.30 \in$. The total cost for using Ultra purge 1220 was $22.904 \in$.

4.4. Analysis and comparison of the tests

Table 10 shows the cost breakdown of using Ramclean 101 purging compound for a color change- from black to green in a plastic injection molding machine with a screw diameter of 50mm. The total cost for this process is 33.5095, which includes the cost of purging compound with black (4.7965), green material mixed with purging compound (6.095), weight of scrap pieces (10pcs)(8.188), machine hourly rate (3.55), and personal hourly fee (10.88).

While Table 11 shows the cost breakdown of using Ultra purge 1220 purging compound for the same color change process in the same machine. The total cost for this process is $22.904 \in$, which includes the cost of Ultra purge purging compound (11.3 \in), purging compound with black (4.18 \in), scrap pieces (3pcs)(2.477 \in), machine hourly charge (1.117 \in), and personal hourly fee (3.83 \in).

From these two tables, we can see that the cost of using Ultra purge 1220 is lower than that of Ramclean 101. Specifically, the total cost of using Ultra purge 1220 is approximately 31% less than that of Ramclean 101. This means that by using Ultra purge 1220, the company can save a significant amount of money in the long run, especially if they frequently perform color changes or purging operations. However, it's worth nothing that the efficiency and effectiveness of the purging process should also be taken into consideration when making a decision, as a more expensive purging compound may be more effective in reducing scrap and minimizing downtime, resulting in overall cost savings in the long run.

Based on the comparison of the two tables, we can conclude that the use of Ultra purge 1220 purging compound is more cost-effective than Ramclean 101 purging compound. Although the

price of Ultra Purge is higher, the overall cost of using it is lower due to its higher efficiency and less waste. In Table 10, the total cost is 33.51, while in table 11, it is 22.90. This means that by using Ultra purge 1220, the company can save up to 10.61 per color change process, which can add up to significant cost savings over time. Therefore, Ultra purge 1220 can be considered a better option for companies looking to improve their efficiency and reduce costs in their plastic injection molding processes.

5. Conclusion

After conducting extensive research and analysis, it can be concluded that purging compounds for extrusion have significant benefits for manufacturers. Purging compounds are essential for cleaning extruders, removing residue, and changing colors efficiently. The use of purging compounds can reduce downtime, improve production efficiency, and minimize waste, ultimately leading to increased profits for manufacturers.

In addition, purging compounds are available in various types, including mechanical, chemical and hybrid, providing options for manufacturers to select the most suitable one for their specific needs. Furthermore, technological advancements have led to the development of more efficient and effective purging compounds, such as Ultra purge 1220 and Ramclean 101.

The cost of purging compounds may seem higher than conventional methods initially, but they offer significant long-term benefits that outweigh the initial expense. Manufacturers can save on production costs by reducing downtime, minimizing scrap and improving production efficiency.

Overall, the use of purging compounds can significantly improve the quality and efficiency of extrusion processes, making them an essential tool for manufacturers in the plastic industry.

6. Summary

In this thesis on purging compounds for extrusion, I emphasized the importance of using these compounds as part of regular maintenance and cleaning procedures for extrusion machinery. I began by discussing the challenges of cleaning extruder barrels, screws, and dies, which can become contaminated with residual resin, colorants, and other materials over time. This contamination can lead to degraded product quality, increased scrap rates, and costly downtime.

To address these issues, I explained that purging compounds are specially designed materials that can effectively remove residual contaminants from extruder components. These compounds typically contain a blend of polymer, abrasive, and other cleaning agents that can break down and remove contaminants.

I as well went on to discuss the benefits of using purging compounds, including reducing downtime and maintenance costs, improving product quality and consistency, and extending the life of the extruder. I also discussed the different types of purging compounds available, such as mechanical purging compounds, chemical purging compounds, and hybrid purging compounds.

Then I provided some practical tips on how to use purging compounds effectively. I emphasized the importance of following manufacturer recommendations for mixing and application, adjusting temperature and pressure settings to optimize cleaning performance, and purging regularly to prevent buildup and maintain cleanliness.

At the end of the thesis I put some result tests on which purging compound a manufacturer should use in order to optimize production efficiency and maintain the quality of the final product.

Overall, the thesis highlighted the critical role that purging compounds play in maintaining the performance and quality of extrusion machinery. By using these compounds as part of regular maintenance procedures, manufacturers can reduce downtime, improve product quality, and extend the life of their equipment.

DECLARATION

on authenticity and public assess of final thesis

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| Title of the document: | The use of purging compounds in extrusion |
| Year of publication: | 2023 |
| Department: | Mechanical Engineering Technology |

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Student's signature

Dohr A4 Internal supervisor

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