Symposium 1

Extrusion, Coating and Joining

S01-147

Compounding technology focused on polymer nano-composites

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Polymer nano-composites (PNC) have been greatly highlighted for the applications to various kinds of polymer related industries, in particular, for automobile parts and food packages. The main differences between new nano-fillers for PNC and conventional ones are the filler size and the filling concentration. Commercial PNC (Polyamid type) has been first produced by a polymerization process. However, various melt compounding methods have been developing to reduce the production cost. The most important key point in melt compounding is how to intercalate and exfoliate clay platelets without severe thermal and mechanical degradation of both the polymer and additives.

S01-1192

THE USE OF GLOBAL MIXING INDICES TO ASSESS MIXING EFFICIENCY IN SINGLE SCREW EXTRUSION

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Plasticating single screw extrusion is a major polymer processing unit. An efficient screw extruder must pump a well mixed melt at the highest possible rate. It is possible to estimate the global mixing efficiency of a given screw via global quantitative dispersive and distributive mixing indices. These indices make it possible to assess the mixing ability of a given screw, to compare a set of screws, or to design a new screw maximizing the mixing performance (e.g., using a optimization-based design methodology). The mixing indices can be computed through a coupling of mathematical descriptions of flow, temperature, pressure and stress along the plasticating screw (i.e., mixing along melting and melt conveying must be computed) with descriptions of morphology evolution of liquid-liquid or solid-liquid systems (whichever the most relevant). In the first case, distributive mixing depends essentially on droplet stretching and residence time, while dispersion takes into account the opposed effects of drop break-up and coalescence. Distributive mixing of solid-liquid systems depends on residence time and location (calculated via entropy), while dispersive mixing considers rupture and erosion phenomena. The present work uses the above concepts to evaluate the mixing ability of both 3-zone screws and screws containing mixing sections. The effects of geometry parameters and operating conditions are discussed.

S01-1214

Recent Advances in Mixing and Extruder Screw Design

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The extruder screw is the heart of any screw extruder. Proper screw design is critical in achieving a stable extrusion process and in producing a high quality product. This paper will discuss how advances in mixing have impacted screw design. New mixing devices that rely on elongational flow have been developed recently. These mixing devices allow single screw extruders to perform tasks that hereto forth required twin screw extruders. Another advantage of elongational mixers is that they can disperse gels; this is very important in film extrusion, fiber spinning, and in the extrusion of thin-walled tubing.Elongational mixing can also be incorporated in barrier sections to improve melting. A new generation of elongational barrier screws will be discussed. The performance characteristics of this new elongational barrier screw will be compared to conventional barrier screws. It will be shown that significant performance improvements can be achieved with the new barrier screw design.Finite element studies on heat transfer in screw extruders have led to the development of the high heat transfer (HHT) screw. The unique flight geometry of this screw forces regions of high melt temperature against the barrel surface while, at the same time, regions of low melt temperature are moved to the center of the screw channel. The HHT screw is particularly effective in tandem foam extrusion lines where large amounts of heat have to be removed in the secondary extruder.Distributive mixing can be improved exponentially by frequent reorientation of the interfaces. A new mixer was developed that achieves mixing similar to the mixing in a Buss Kneader. This mixer uses a floating sleeve with internal pins that intermesh fully with the flights of the screw. This vortex intermeshing pin (VIP) mixer achieves highly effective distributive mixing. It has proven itself very effective in the most demanding mixing j

S01-120

An Overview on the Use of Acid and Ion-Containing Compatibilizers to Compatibilize Polyethylene-Polyamide 6 blends

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Our group has extensively investigated the use of acid-containing materials as well as partially neutralized materials to compatabilize polyethylene-polyamide 6 blends. These materials have been shown by us and other groups to be effective compatibilizers for this system; and most of the evidence suggests that it is a reaction between the primary amine endgroup and the acid group that causes compatibilization. The necessary amount required for compatibilization is very small; on the order of 1% of compatibilizer that contains 5 mole percent of acid groups. Surprisingly, decreasing the concentration of acid groups via neutralization actually improves compatibilization. Recent work has found that this effect is independent of cation type; suggesting perhaps that metal-neutralized materials are able to more effectively partition to the interface.

S01-169

Temperature Modelling Inside the Screw Channel for Internal Tempered Screws

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To achieve a constant product quality during extrusion and injection molding processes it is of utmost importance to keep a certain mass temperature inside the screw channel and over the screw length. Local temperature peaks have to be avoided, for they can lead to thermal degradation of the material. For the theoretical characterization of the radial temperature profile inside the screw channel and the resultant temperature profile over the screw length mathematical-physical models are needed. With help of these models it is possible to design a plasticizing unit optimal for the particular application.Modelling of temperature profiles for screws without internal tempering is covered by the state of the art. However, the calculation of radial temperature profiles of thermoplastics for internal tempered screws was not possible on basis of existing mathematical-physical models until now. So far the screw was regarded as an adiabat object without heat flux into the screw. Within a state-aided project of the DFG (Deutsche Forschungs Gemeinschaft) a temperature model on basis of existing calculations for the radial temperature profile inside the screw channel without internal tempering was developed. In these studies the assumption of an adiabat isolated screw was replaced by a constant heat flux from the melt into the screw, which is implicated into the calculations. So in this case a constant heat flux from the melt through the screw into the cooling medium exists in addition to the heat flux from the cylinder into the melt. Consequently, the energy equation was solved with two constant boundary conditions and one starting condition.The model of the radial temperature profile for internal tempered screws inside the channel and first practical results are presented in this paper.

S01-204

Flex Ring Pipe Dies open up new processing possibilities

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Conventional pipe dies consist of a solid mandrel and a solid outer ring. With such dies the thickness distribution in pipes can only be influenced by centring the die. Two thick regions situated opposite each other can not be fought. This is possible when you retrofit a multi-walled flex ring sleeve into the outer ring of a pipe die. Similar to the well proved flex lip technique in flat film production the Flex Ring technology allows for a locally limited adjustment of the flow channel gap. Even the thickness distribution of single layers in coextruded pipes can be fine tuned. The basics of this new technology will be explained and examples from retrofitted pipe dies will be presented.

S01-274

THE EFFECT OF WALL SLIP ON THE PERFORMANCE OF PROFILE EXTRUSION DIES

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In the last years, this research team successfully implemented and validated an optimisation methodology [1], encompassing the numerical solution of flow and heat transfer equations by a finite-volume based three-dimensional code, aimed at balancing automatically the flow in complex profile extrusion dies, where the non-slip boundary condition at the die channel walls was assumed. More recently, the wall-slip boundary condition was implemented in the above referred numerical code [2], making this tool more powerful, since it will be capable to model adequately the behaviour of polymers often used in the production of thermoplastic profiles, such as poly(vinyl chloride) (PVC), high-density polyethylene (HDPE) and elastomers, that, under certain conditions, exhibit wall-slipping at the die walls. In this work, the studies done assuming melt adhering to the wall were extended to slipping materials: i) in a first stage, the effect of this boundary condition on the final optimum die geometry will be studied. For this purpose, optimisations will be carried out using different levels of polymer melt wall-slip at the die walls; ii) in a second stage, two different strategies, length and thickness based, will be used to optimise the flow channel of a die for the production of a specific profile. The performance of the two resulting dies will be compared in terms of sensitivity of the flow distribution to fluctuations of the operating conditions and/or variations of the polymer melt rheology.References[1]J. M. Nobrega, O. S. Carneiro, F. T. Pinho, and P. J. Oliveira, “Flow Balancing in Extrusion Dies for Thermoplastic Profiles - Part III: Experimental Assessment”, International Polymer Processing, 19(3), 225-235, 2004.[2]L. L. Ferrás, J. M. Nóbrega, F. T. Pinho, O. S. Carneiro, “Optimisation of profile extrusion dies: the effect of wall slip”, 23th Annual Meeting of the Polymer Processing Society, PPS-23, Salvador, Brazil, 2007

S01-289

Increased surface energy by functionalization and coating with the Plasmaline

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The Plasmaline(r) is a new type of low temperature plasma jet which allows uniform surface treatment of large areas in the homogeneous afterglow. This technique has no limitations regarding substrate thickness, which makes it complementary with corona systems. Furthermore there’s no risk for substrate damage or back treatment. Plasmaline(r) treatment of surfaces with gasses such as nitrogen or carbon dioxide increases surface energy, as has been shown by contact angle measurements. For this reason, it is a good pretreatment to increase adhesion with for example glues, coatings or inks. The special design allows central injection of chemicals into the most reactive part of the plasma afterglow. Thin coatings were deposited by using organic and siloxane precursors with specific functional groups, which results in permanent wettability. XPS shows that different chemistries can be induced.

S01-304

The Control of Extrudate Swell and Instabilities using the Rotating Roller Die

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ABSTRACT– Polymer extrudates exiting from dies will always swell (in all directions) and above a critical flow rate display instabilities [1] such as “sharkskin defects”, “stick-spurt”, or “gross melt fracture”. The common approach to control these phenomena is either to reduce screw speed hence flow rate (not a favourable option) or manipulate temperature which also does not give much option in increasing flow rate. One alternative to remedy this problem is by coating the inside of the die with slip agents so as to reduce flow acceleration, the main source of swell and instabilities. A second alternative is to round off the die lip so as to relieve the stresses at exit which in turn reduce acceleration. Clearly, inducing slip-by any means- is helpful but with current technology there is a limit in practice as over time the die wall loose the slippery coating applied. The rotating roller die- a new development in polymer processing but based on traditional technology- can provide real slip in the sense that the flow can be aided by the walls which are moving unlike the classic stationary wall dies. In an earlier presentation [2], we presented some evidence on the ability of this new die to control swell and reduce instabilities but which was limited to one roller gap (4mm), one polymer (PS) and one temperature (180 C). In this paper, we present more extensive data to underpin the claim we make that this new die is indeed a versatile tool to control swell and instabilities and very importantly postpone these to higher flow rates. REFERENCES1. J-F. Agassant, D. R. Arda, C. Combeaud, A. Merten, H. Munstedt, M.R. Mackley, L. Robert and B. Vergnes Proceeding of Polymer Processing Society 21, Leipzig, 2005, 1.2. H.Benkreira, A.P.Preece, R.Patel and P.D.Coates, Proceeding of Polymer Processing Society 23, Salvador Brazil, 2006.

S01-361

A Composite Computer Model for Counter-Rotating Twin Screw Extrusion

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A global computation model TSEM (Twin Screw Extrusion Model) has been developed for starved fed closely intermeshing counter-rotating twin screw extrusion. Based on a local 1D approach, the model predicts polymer melting behaviour, fill factor and pressure as well as temperature profiles. It is validated experimentally. The simulation parameters are material properties, screw and die geometry, and operating conditions. Moreover, Genetic Algorithms are proposed for optimization of the process, and FEM Polyflow-Fluent simulations are considered to improve the melt flow description.

S01-596

Processing additives based on polyols and silanols for extrusion of polyolefins

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Polyolefins represent roughly 60 percent of all the thermoplastic polymers produced and sold in the world. The present revolution in polyolefins production is the development of metallocene catalysts. The polyolefins with narrow molecular weight distribution made by use of metallocene catalysts are tougher, stronger and cleaner than plastics made with conventional catalysts. Meanwhile they cannot be processed by extrusion without Polymer Processing Additives (PPAs). PPAs are lubricants to reduce extrusion pressure and eliminate extrusion defects, gel-streaking and pinstriping. Nature uses elastic gels as lubricants in joints of bones, and demonstrates excellent results in lowering of sliding friction. Human technologies differ very much from natural ones. Due to the historic development of technology, fluorinated polymers dominate the use of external lubricants and PPAs for polyolefins. The PPAs made from fluorinated polymers are inherently costly, but the main problem in the using fluorinated polymers is that they are not friendly to the environment. Taking from Nature the idea of elastic lubricants, we developed novel PPAs that do not contain fluorine. These lubricants are made from Polyethylene glycols (PEGs) and PEG-silanols blends cured by borates. The novel PPAs show better lubrication efficiency in comparison with conventional (fluorinated) PPAs and a very short conditioning time to suppress sharkskin flow instability. They are hydrophilic opposite to hydrophobic fluorinated PPAs. Other polyols, their derivatives and blends can be also used in the PPA composition. With the use of silanols cured by borates mechanical properties of the lubricant were changed by small variations of composition to investigate the impact of elasticity on lubrication and suppression of sharkskin. Both lubrication and efficiency to suppress sharkskin were considerably improved when more elastic lubricants were used while the chemical composition of the lubricants was nearly the same

S01-605

Slot-Die Coating of Aqueous Poly(Vinyl) Achohol Solutions

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An experimental study was carried out to investigate the effects of molecular weight and concentration of aqueous poly (vinyl) alcohol (PVA) solutions on the operating window of slot die coating. The operating window is defined as a close domain inside which uniform and stable coating can be established. Different types of coating defects can be found outside the operating window. It was found that the operating window expands with increasing PVA concentration until a critical concentration C* is reached. This critical concentration corresponds to the gel-point of the PVA under investigation. The onset of flow instability was found to be a strong function of fluid elasticity. For most polymer solutions, higher polymer concentration or high molecular weight would result in a higher Weissenberg number (Wi). Below the critical Weissenberg number, fluid elasticity is insignificant and the increase in viscosity would widen the operating window, while further increase in Wi beyond its critical value, elastic effect becomes dominant and the window would shrink in size. The operating window of PVA with higher molecular weight is larger than that of PVA with lower molecular weight at the same concentration. Comparison of operating window of PVA solutions with low-molecular-weight glycerin solutions at the same viscosity and surface tension reveals that the long-chain molecules of PVA solutions can effectively stabilize the fluid motion in the coating bead region and expand the operating window.

S01-834

Induction Welding - Flexible Joining Technology for Fiber Reinforced Thermoplastic Polymer Composites

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Joining is an important step in the manufacturing chain of thermoplastic fiber reinforced polymer composites (TFRPC). The availability of reliable, flexible, and cost-efficient joining processes is crucial for the increased use of composites and the substitution of metallic structures. Induction welding is an innovative joining technique for TFRPCs that uses an electromagnetic field for heating. Carbon fiber reinforced thermoplastic polymers can be directly heated whereas glass fiber reinforced materials need additional welding fillers, such as metal meshes. For woven reinforcements and metal grids the main heating mechanism is Joule heating in the fibers due to induced eddy currents which leads to melting of the surrounding matrix. Subsequent to the heating step, the weld is consolidated under pressure. As a unique characteristic of this process, the joint is produced sequentially by a generic tool that can be universally used for different weld geometries. Up to now, this technology was restricted to flat, straight seam designs. Within the framework of a joint research project this limitation is overcome by a newly developed welding unit that is guided by a six-axis industrial robot allowing curved weld designs. The paper will present an investigation of the main process parameters for the induction welding process and their influence on the weld strength by mechanical and morphological analyses of GF/PA6 single lap joints. The process window of the matrix polymer was determined by differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). For optimized processing of glass fiber reinforced polymers a comparison of the heating behavior of different welding fillers was drawn by thermography measurements.

S01-847

Volatile organic compounds evolved from unstabilized polypropylene during extrusion

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Emission of volatile organic compounds (VOCs) during extrusion melt processing of polypropylene was studied. Two unstabilized commercial grades polypropylene were processed at different temperatures (180, 200, 220, and 240oC) in a Werner&Pfleiderer ZSK-30 twin screw extruder, keeping all other processing condition constant. Evolved VOCs were collected in a gas trap condenser (cold finger type), fitted at the degassing port of the extruder. The condensed VOCs were removed from the trap via solvent wash and were analyzed via FTIR, GS/MS, and SEC. Extrusion temperatures greater than 220oC have produced high levels of thermo-mechanical degradation, seen as greatly reduced melt viscosity and increased concentration of VOCs. FT-IR shown that they are composed manly by oxidized olefinic compounds.

S01-897

Relation between Viscoelasticity Behavior of Multilayered Polymer Solution and Surface Appearance of Liquid film

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In this study, it aimed to evaluate by using three layer channels for the polymer solution for the influence that the flow condition (flow rate ,shape of channel and solution property) in the channel exerted on the liquid film surface appearance immediately after the discharge, and to clarify the rule factor in which it influenced the liquid film surface appearance. It experimented by taking a picture of the bead surface appearance immediately after the discharge with a high-speed camera by using three layer channels where the change in the merging point shape was possible. As a result of the examination, the following result was obtained.(1)As a result of the observation of surface, it has been understood a peculiar surface ruggedness (thickness irregularity) is generated when the viscoelasticity fluid is used a direction of the liquid film discharge different from Melt fracture and Sharkskin. It is thought that this irregular thickness is a peculiar phenomenon to the viscoelasticity fluid, because when Newtonian fluid is injected, this irregular thickness is not generated, and it is suppressed because of a residence time in channel increase.(2)The factor separation between layers is done an irregular thickness to specify the rule factor, therefore it has been understood that the correlation is strong in the first normal stress difference generated in the sub-fluid when merging for the incidence of this irregular thickness. Concretely, it has been understood that a thickness irregular incidence increases as the first normal stress difference generated in the sub-fluid when merging grows. Moreover, it has been understood to be able to disregard the influence of the main-fluid on the incidence of an irregular thickness in this system.

S01-1216

How to Achieve Stable and Efficient Extrusion

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The foremost objective in an extrusion operation is to achieve a stable and cost-effective extrusion process. This paper will outline basic requirements for a stable extrusion process, process methods that enhance process stability, and tools that can be used to maintain a stable process.The basic requirements relate to the six major factors that influence the process. These main categories are machine, personnel, method, material, measurement, and environment. Each of these categories will be discussed in detail with emphasis on machine design options that lead to a robust process. Process methods can have a strong influence on process stability. For instance, starve feeding can lead to significantly improved process control.Tools to maintain a stable process include process monitoring capability. Basic requirements of a process monitoring system will be presented. Examples of actual process data and how it can be interpreted will be presented. Finally, the use of statistical process control will be discussed.

S01-1248

VISCOELASTICITY IN SCALE-UP OF EXTRUSION

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Scale- up rules in single extruders relies on power law relation of mass flow rate to diameter of an extruder. In comparison scale-up in twin screw extruder is complicated by channel depth and heat transfer from cylindrical wall to a polymer. the temperature development in small test extruders will be different from that in larger ones, with all consequences for viscosity differences (mixing) and thermal degradation with the more recently developed high-melting-point polymers. Dimensionless temperature (initial temperature and the die temperature of each operating point) and dimensionless power consumption (ratio of power to mass flow rate, specific heat capacity and temperature difference) have been used for scale-up process. In composites and cross-linked polymers, elasticity can be significantly higher than viscosity. Polymers with different levels of cross-linking with and without fillers were analyzed and equilibrium plateau modulus was obtained using time temperature superposition. Equilibrium plateau modulus, characteristic of polymer network shows a power law dependence on melt flow index in a particular extruder. On scale-up, power law exponent decreased from higher die temperature and lower frictional heating from lower shear stresses in the extruder.

S01-119

Processing of Single-Walled Carbon Nanotubes with Polymer Latex

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Single-wall carbon nanotubes (SWNTs) were dispersed in water using the surfactant sodium dodecylbenzenesulfonate to facilitate dispersion. Styrene-isoprene copolymer (S-I copolymer) and SWNT composites were prepared by emulsion polymerization and miniemulsion polymerization in the presence of SWNTs, as well as by mixing the dispersed SWNTs with S-I copolymer latex after polymerization. During polymerization in the presence of nanotubes, surfactant was displaced from SWNTs to monomer droplets resulting in aggregation of SWNTs during the reaction. The resultant composite had significantly worse mechanical properties than the polymer made without nanotubes, and no improvement in electrical conductivity was found. Mixing dispersed SWNTs with the latex after reaction kept SWNTs in their dispersed state and gave a polymer composite with an electrical percolation threshold of 0.2%. No substantial differences were found between composites formed from latices produced via emulsion or miniemulsion polymerization. Mechanical properties of the copolymer significantly improved at SWNT weight fractions as low as 0.1%. Dynamic mechanical analysis of film samples in tension showed that the composites had a measurable modulus above the glass transition temperature (Tg) and that the modulus increased with increasing nanotube content, indicating that entanglements had formed giving mechanical stability to the composite. The modulus above the Tg was strongly temperature dependent, confirming shear measurements made by others that showed entanglements in nanotube/polymer composites involve both polymer and nanotubes.

S01-124

Pressure/flow performance of viscoelastic polymeric melts in Cylindrical Channels

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One of the most widespread practical methods of polymer processing is the extrusion method that is based on pressing a polymeric melt through channels of the molding tool which have dif-ferent geometrical cross-sections. The basic performance of extrusion is based on the pres-sure/flow performance which sets functional correlation between volumetric flow rate of a poly-mer medium, pressed through a molding tool, and created pressure drop. Arguments of this cor-relation are the rheological parameters of polymer and the geometrical characteristics of the channel in which the polymeric melt flows. In this paper a viscoelastic model with a corrected strain energy function is implemented. The comparison of revealed theoretical expression in this paper with the experimental data for flow of polymeric melts in cylindrical channels with various cross-sections demonstrates a good convergence over a wide range of pressure gradient.

S01-200

Selected aspects of examining the geometric structure of cellular polyethylene extrusion products

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The modification of the layer of an telecommunication cable also concerns the making of the layer from the foaming polymer, which will cause the decrease of its weight, and through that, polymer purchase costs and transportation costs. It causes simultaneously the replacement of the conventional coating extrusion process with the foaming extrusion process. However, most often, because of good mechanical properties and many other advantages, they are first of all made from high density polyethylene (PE-HD). The efficiency of building an telecommunication line is connected with the problem of installing long cable fragments inside protective pipes in the shortest time. Complex tribological dependences have a decisive significance in this process.The aim of the conducted research was to get to know the influence of modifying polyethylene with the selected agents, that is a foaming agent on the course of the extrusion process, including the establishment of the influence of modification on selected physical properties and properties of polyethylene extrusion product surface. The further aim was the estimation of the studied polymer in regard to required conditions and properties of surface layers of the cables.As a foaming system, Hydrocerol was used and dosed in the range 0,2 – 0,8%. Hydrocerol has a granulate form of a grain diameter from 1,2 to 1,8 mm and contains 70% by mass of a foaming agent of an initial degradation temperature 140°C. The foaming agents were chosen suitably to the type of the processed polymer and according to the rule that the temperature of its distribution should be higher than its melting temperature, but lower than polymer extrusion temperature. The temperature of the extruder head should be close to the temperature of the foaming agent distribution. The extrusion process of the modified polyethylene was conducted on the extrusion technological line by Nokia Maillefer company used to the production of the panel (the element filling

S01-223

Improvement of extrusion processability for metallocene PP random copolymer by blend of metallocene LLDPE

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Polymer blend is a practical method to improve processaiblity or to obtain preferable material properties when any of neat polymers are not sufficient for the purpose. It requires blending polymers with different nature such as polar and non-polar polymer to achieve expected quality so that compatibilizer is sometimes combined for fine dispersion. Blending of polyethylene and polypropylene is seemingly facile procedure without any compatibilizers as both components are polyolefin. In actual processing, however, it is difficult to obtain a compatible compound despite of the similarity of chemical property. One of reported facts was that specific ethylene-@-olefin copolymers are only miscible to isotactic polypropylene, but not to syndiotactic polypropylene. Another report indicates that metallocene polyethylene is better than Ziegler-Natta polyethylene to blend with polypropylene. In this study, extrusion porcessability of metallocene polypropylene random copolymer (mPP) was improved by blending of metallocene linear low density polyethylene (mLLDPE) for extrusion coating. The mechanical properties of the extruded film were also evaluated. It is found that the processability is improved by blending 20 weigh % of mLLDPE in an extruder. The tensile strength of the extruded film in machine direction was also improved by blending of mLLDPE up to 20 weight %, while it was proportional to blend ratio in transversal direction.

S01-330

Preparation of polysaccharide based pellets for crayfish farming by extrusion tecniques: influence of pellets composition, water sorption and solute leaching on crayfish growth

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This study represents an innovative experimental approach aimed at developing crayfish farming under intensive conditions. Two algal polysaccharides, alginate and agar, chitosan from chitin, and one fruit extracted polysaccharide, pectin, have been used as food additives. On the basis of specific macromolecular structures, peculiar rheological behavior and well-known physical properties, the selected polysaccharides have been used and tested in form of hard pellets. We examined the performance of the pellets in water and their effect on crayfish growth. The kinetics of water absorption and solute leaching of pellets were measured up to 24 hours. Recovered liquid was analyzed for the release of particles in water by Low Angle Laser Light Scattering Technique. At the same time, crayfish feeding response to pellets was monitored in growth experiments by testing diets containing the same amount of nutrients (proteins, lipids and carbohydrates) mixed with each one of the different polysaccharides. The presence of polysaccharides positively affected crayfish growth. Indeed, animals fed pellets showed a higher percentage of growth when compared to animals fed a fresh diet. The polysaccharides used for making the pellets were extracted from available and renewable resources, such as potentially polluting residues of marine and agricultural origin. As important consequence, the costs relative to the extraction of raw material are relatively low. The gainful economical feature, the simple methodology used for pellets preparing and the remarkable results obtained from our research, could be considered as suitable parameters for people interested in farming crayfish under intensive conditions.

S01-348

On the Applicability of Boundary Layer Theory in Creeping Flows of Polymer Melts through Converging Channels: A Numerical Solution

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In the present work, we have investigated the applicability of boundary layer theory to converging flows of polymer melts while the Reynolds number is vanishingly small. Assuming the flow to be non-radial and two-dimensional, a series-solution is utilized to convert the governing equations into a set of coupled ODEs. The Keller-Box method will then be used to solve these equations for the streamline pattern and also the velocity field. It is shown that in the extrusion of molten polymers through tapered slit dies (say, for the production of plastic sheets) the use of boundary layer approximation may be warranted, even under creeping flow conditions, provided that the fluid is sufficiently strain-softening. To show this, three different constitutive equations have been used for the analysis, i.e., the Maxwell model, the Giesekus model, and the Phan-Thien-Tanner model. The results obtained in this work suggest that between these three rheological models, the applicability of boundary layer theory at low Reynolds numbers is more plausible for the PTT model. It is also shown that the extensional parameter in the Giesekus and PTT model has a strong influence on the formation of secondary flow in the channel.

S01-450

Extrusion of chalk-filled PE-LLD-regranulate blown films by applying different processing methods

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Three different processing methods to manufacture chalk-filled PE-LLD-regranulate blown films are analysed in this paper. First, a compound is produced on a co-rotating twin screw extruder which is processed on the blown film line. Then a master batch with 50 wt% chalk is produced which is mixed with the polymer in the single screw extruder of the blown film line. Finally, direct extrusion of chalk and polymer is carried out. The amount of chalk is then varied between 0 and 20 wt% in steps of 5 wt%, and the processibility of the material and the maximum output are determined. The mechanical properties of the blown film are investigated by means of a tensile test of the blown film at four circumferential positions in machine and traverse direction.Additionally the processibility of three different chalk types is analysed using the Rheotens-experiment and blown film extrusion. The amount of chalk in the polymer is varied between 0 and 50 wt% in steps of 10 wt% in these experiments. The results of the Rheotens-experiment and blown film extrusion are subsequently compared.Chalk-filled PE-LLD-regranulate blown films processed by direct extrusion show insufficient dispersion of the particles in the polymer. A concentration of 5 wt% filler already leads to a significant decrease in tensile strength and elongation at break. When mixing the master batch with the polymer on the blown film line no reduction in tensile strength up to 10 wt% filler concentration is observed. In contrast to that, the elongation at break decreases significantly. Agglomerates and streaks are observed in films with a filler concentration higher than 10 wt%. Above that and mainly in the machine direction, a significant reduction in the mechanical properties occurs.Films of compounds produced on a co-rotating twin screw extruder even show no decrease in tensile strength even at 20 wt% filler concentration, but the elongation at break decreases in comparison with the unfilled films.

S01-652

Influence the cooling way on mechanical properties of extrudate

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The characteristic of extrusion process of PE-HD at different ways of cooling extrudate in order to improve the diversification of properties and extrudate structure was presented in the article. The conditions and course of the plasticizing process in screw unit and the polymer flow in extruder canals and die have basic importance for obtaining the extrudate of defined properties. On the basis of previous research it was determined that besides processing conditions and also the unintentional or intentional caused changes of the extrudate plasticizing state have an influence on increase efficiency of obtaining extrudates of strictly defined features and properties. Area of the biggest value of temperature changes of processing extrudate is between extruder die and calibrator entrance. In dependence on the way and intensiveness of extrudate cooling in this field is it possible to influence on properties and structure of surface layer. The course of temperature changes of extrudate layer in dependence on assumed way of cooling in water and air was presented in the article. The characteristics of changes of selected mechanical properties of received extrudates were shown. The evaluation of changes of structure and crystallization degree in dependence on the cooling way and received extrudates was made.

S01-687

Processing and characterization of high performance coatings based on the use of PVA nanofibre for acoustic insulation

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In the last years, the use of high performance coatings at a nano-scale with the general scope of sustainable development has increased in a remarkable way. Traditional acoustic insulating systems are been progressively substituted by new systems which offer some advantages against traditional ones such as higher acoustic insulation efficiency, environmental friendly materials, less material consumption, recyclabibily, upgrading, … Considering this background, some textile materials have been widely used as acoustic insulating materials for different building elements, whit excellent acoustic insulation properties due to the porosity of the textile product as well as the wall thickness. Nevertheless, these “traditional textiles” based on conventional fibres show good insulating properties at high frequencies and they do not cover the appropriate acoustic insulation at low frequencies, which is an interesting research field. The aim of this work is to optimize the processing conditons of an electrospinning process (viscosity, electrical conductivity and wettability, electrode separation length, applied voltage) to obtain new nano-scale coatings structures based on the use of a non-woven polypropylene as a collector substrate and a deposited nanolayer of polyvinyl alcohol (PVA) nanofibres. These new surface coatings could find uses in building applications as acoustic insulating material in the low frequency range. The results show that as the applied voltage increases up to values in the 50-52 eV range, the average diameter of the PVA nanofibre is decreased up to values in the 200-220 nm range; this structure promotes certain porosity which is responsible for the acousting insulating properties, mainly at low frequencies. This is interesting to obtain new coatings in a simple way, with an environmental friendly process (electrospinning process with aqueous solutions) for uses in acoustic applications. These coatings can be used as resonant materials and offer some ad

S01-798

DESIGN AND MANUFACTURE OF EXTRUSION DIE FOR A WOOD PLASTIC COMPOSITE PROFILE

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Flow balancing in polymer extrusion processing is an important issue as an unbalanced flow at the die exit causes an undesirable extruded profile. This case specially is critical in complicated profiles. This paper presents a simulation study and experimental verification of an industrial die that has been manufactured to product an I-shape wood-plastic composite profile. When profile is complicated that have wide dimensions and various thicknesses, this case will be more important. For designing die channel to yield a balanced output, finite element method has been used. Die design and manufacture phases of this wood-plastic composite profile is presented. The results show that prediction of simulation could give a good insight to the die design which yields an acceptable profile.

S01-896

Increase of the abrasion resistance of a varnish based in urethane-acrylate oligomer using residues of windshields

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The windshield after its use is of difficult recycling, mainly the residue of fine glass (with small granulometry). This material is characterized as a residue once it cannot be recovered in the glass industry, because in the furnaces of glass fusion the use of this material is avoided due to the deposition of this material into the internal walls of the furnaces and the drag of this fine powder through the chimney.1 In this work two different granulometries of this fine glass - 200 mesh and 325 mesh – were used as a filler in a varnish based in a urethane-acrylate oligomer used to cover and protect wood flooring. The cure of this varnish was through ultraviolet radiation. The results show that the abrasion resistance of the varnish with the addition of the fine glass increased significantly.

S01-1133

Laser speckle techniques in molecular mobility evaluation of plasticized starch-based films

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The use of edible films and coatings is constantly increasing in the food industry. Plasticizers, such glycerol are often used to modify the mechanical properties of the film. These compounds decrease intermolecular attractions between adjacent polymeric chains, thus increasing film flexibility. Molecular mobility and phase transitions affect physicochemical properties. The dynamic speckle, which is a phenomenon occurring when coherent light is scattered by objects exhibiting some type of activity. The intensity in each point of the scattering pattern changes in time in a seemingly random fashion, but those intensity variations are related to, and carry information about, the activity in the object. The activity on the object may result in individual scatterers movement, changes in optical paths due to changes in refractive index, or combinations of both. In this work, the molecular mobility of plasticized starch-based films as inferred from the dynamic speckle patterns generated by them are investigated, with the aim of developing a method for phase transitions and drying assessment. Two methods are employed in order to evaluate quantitatively and qualitatively the activity of the dynamic speckle patterns. One of them is based on the calculation of the moment of inertia of the co-occurrence matrix in the time history of the speckle patterns (THSP). The other is a display where the activity of the sample is shown as an image by using a generalized differences (GD) method. Potato starch (2g) and glycerol (0%, 15%, 20% and 25%) were dispersed in 100 ml distilled water. The suspensions were obtained by heating until 92,5°C, with constant mixing and then cooled to room temperature. The solutions were dispersed on 110 mm diameter polystyrene plates and were analyzed with biopeckle laser for 46 h at ambient temperature. The biospeckle laser can be an important tool to evaluate the molecular mobility in starch-based films.

S01-1352

COMPLEX PROFILE COOLING: THE EFFECT OF PROCESS AND GEOMETRICAL PARAMETERS

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In profile extrusion the cooling stage is a very important step, as it affects the final dimensions of the profile, its dimensional stability and its mechanical performance. Moreover, as the profile progresses along the extrusion line is subjected to a variety of external forces, such as friction, buoyancy and compression. Hence, the calibration stage must ensure that the incoming melt is properly shaped, and that the outgoing profile is rigid enough to withstand the external forces. From a thermal point of view, the calibration step must ensure fast rate uniform cooling of the extrudate, in order to induce the appropriate morphology and a uniform level of thermal induced residual stresses. Unfortunately, heat removal during the cooling stage is very difficult to anticipate, especially in the case of complex profiles. Therefore, the ability to numerically model the profile cooling is an important tool to assist the extrusion designer. For this purpose, a numerical code, based in the Finite Volume Method able to solve the energy conservation equation, with 3D unstructured meshes for unsteady problems, is being developed by the authors. In this specific work, this code will be employed to study the effect of some process and geometrical parameters (e.g., cooling channel dimensions and layout, cooling fluid temperature, production rate, split of the cooling length into several independent units) in the cooling process of a complex profile.