

SPRING 2026

SOCIETY OF PLASTICS ENGINEERS
CADNEWS



RETEC SURVEY ANALYSIS

TECHNICAL ARTICLE

**FUNDAMENTALS OF TWIN-SCREW EXTRUSION
COLOR MB PROCESSING: COMMON PITFALLS &
HOW TO AVOID THEM**

BY PAUL G. ANDERSEN, COPERION CORPORATION



**COLOR AND
APPEARANCE
DIVISION**

COLORING THE WORLD OF PLASTICS



CHAIRMAN'S MESSAGE

“Spring is the time of plans and projects.” — Leo Tolstoy, Anna Karenina

Welcome to the 2026 Spring edition of CAD News! Spring has arrived full force with sunshine, longer days and our frenemy, pollen. For those of you on the allergy train, my condolences! I too suffer from those woes.

With the arrival of Spring comes the election of our CAD Board of Directors. Please be sure to visit our webpage, www.specad.org, and the elections tab for more information. Serving on the board is a rewarding and challenging experience. Thank you for your part in choosing who gets to serve and improve the activities of the Color and Appearance division. And, as always, let us know if you have any interest in joining the team.

Plans are underway for this year's CAD RETEC Conference “Where Color Leads the Field” in Louisville, Kentucky. Stay tuned for more communication as we get closer to the event. We look forward to seeing you again! If you require any support right now, feel free to reach out to this year's conference leads – TJ Stubbs (tstubbs@teknorapex.com) and Bruce Mulholland (captcolour@gmail.com).

I hope this newsletter is both entertaining and instructive for you.

Take care and enjoy your day!

KIMBERLY WILLIAMSON

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Newsletter Editor

Mark Tyler

Technical Content Coordinator

Cory Singleton

Communications Committee

Jeff Drusda

Earl Balthazar

Matt Billiter

Mark Tyler

Ann Smeltzer

Mark Ryan

Mercedes Landazuri

Doreen Becker

CAD RETEC® 2025 SURVEY RESULTS

BY BRUCE MUHOLLAND

Thought I'd take a few minutes to let you all know that we actually do read and consider the selections and comments obtained from the survey results at CAD RETEC®. These surveys are much more than just allowing you to participate in the raffle at the end of the conference. We really do value your opinion and do want to hear from you!

We had about 110 surveys submitted, with only 72 where the questions were actually answered. The remainder were submitted blank just to get into the raffle. Please try to complete these, even if you know you won't be present for the raffle (you must be present to win). So here are some results from the 2025 Survey.

WHO ARE WE?

45.8% of attendees are Sales and Marketing folks followed by 37.5% Technical/R&D.

HOTEL PREFERENCE?

Over 98% of respondents selected Marriott solely or in combination with another brand. Actually no surprise there!

HOTEL RATE?

56% said the hotel rate doesn't matter, and about 50% said they'd pay up to \$250/night while the other 50% said they'd pay more. As the CAD Board of Directors, please rest assured that we work extremely hard to keep the hotel room night cost as low as practical. This does prevent us from going to locations such as Nashville which has become very expensive (>\$300) for hotel rooms.

INDUSTRIAL LOCATION?

Philadelphia slightly edged Chicago and Cincinnati with no city gaining more than 18% of the votes.

DESTINATION LOCATION?

Savannah and New Orleans were the top vote getters, each collecting more than 30% of the votes.

ROTATING CITIES?

The majority of respondents prefer rotating cities, while a more limited rotation did show significant support.

MOBILE APP USAGE?

53% responded that they used the mobile app. Hopefully this will continue to increase as we rely less on printed materials.

CONFERENCE MET EXPECTATIONS?

This question is similar to a Net Promoter Score, and we scored 8.5 out of 10. I think that's good, but hopefully we can continue to push that rating to 10 over the coming years!

NEW TECHNOLOGY FORUM (NTF)?

Over 80% of respondents like the NTF and think the one-hour format is good.

DISCOUNTED REGISTRATION PACK?

85% said they would like to see us offer a discounted registration pack. So for 2026, you will see a 5-pack registration option offered. It is essentially a buy 4 get 1 free registration pack that you will be able to use for employees or important customers! (See, we listen!)

PANEL DISCUSSION TOPICS?

Top choices continue to be Regulatory, Sustainability and Color Trends.

COMMUNICATION PREFERENCE?

92% of people responded that they prefer email communications. So make sure you check your spam folders!

OPEN-ENDED COMMENTS?

Probably the single most mentioned comment was having more time to see the exhibits/tabletops and even closing tabletops during presentations. Again we listen and we will try to incorporate changes to the CAD RETEC® 2026 program. Stay tuned!

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CAD RETEC® 2025 SURVEY

SPE Color & Appearance Division Questionnaire 2025

Win one of many great prizes at the raffle on Wednesday, September 17th.
Your completed questionnaire is your entry to win.

What is your job function?

Technical/R&D Sales/Marketing President/CEO Student/Academia
 General Manager Procurement Production/Ops Other _____

Where is your physical office location:

R&D/Lab Plant Site Home Office Sales/Business Office

CAD RETEC® Hotel Preference Questions:

Does the hotel brand (Marriott, Hilton, etc) impact your decision to attend: Yes No
 If yes, which brand Choice Hilton Hyatt IHG Marriott Wyndham Other
 Does the hotel room rate impact your decision to attend CAD RETEC®: Yes No
 I would be willing to pay \$200 - \$250 per night: Yes No
 I would be willing to pay \$250 - \$300 per night: Yes No
 I would be willing to pay >\$300 per night for a destination location: Yes No

The CAD Site & Theme Committee is considering locations for future CAD RETEC® conferences.

Category 1: Industrial Location (vote for one)

Atlanta Chicago/Area Cincinnati Indianapolis Kansas City
 Minneapolis Philadelphia Pittsburgh St. Louis Other: _____

Category 2: Destination Location (vote for one)

Baltimore Dallas Jacksonville Memphis New Orleans
 Orlando Savannah Other: _____

Did you use the Event Mobile App? Yes No

What statement best describes your location preference? I like rotating cities/venues every year
 I prefer the same location each year
 [Select only one from the right] I would like a limited rotation (how many cities: _____)

On a scale from 1 to 10, where 1 = not at all, and 10 = definitely yes, how well did this conference meet your expectations? Circle One: (Not at all) 1 2 3 4 5 6 7 8 9 10 (Definitely Yes)

Detach at the CAD RETEC® registration desk

Do not write in this area

Please go to back of Page

CAD RETEC® Information	
Do you like and attend the New Technology Forum?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Do you think the hour length is good, or have more talks?	<input type="checkbox"/> 1 hr is enough <input type="checkbox"/> Have more talks
Do you like the idea of being able to purchase a 5-pack or 10-pack of discounted registrations to give out to employees and/or customers?	<input type="checkbox"/> Yes I like the idea <input type="checkbox"/> No I do not If yes, <input type="checkbox"/> 5-pack or <input type="checkbox"/> 10-pack
What topics would you like to see included as a panel discussion or focus topic (check all that apply)?	
<input type="checkbox"/> Regulatory (Colorants) <input type="checkbox"/> Marketing <input type="checkbox"/> Color Trends <input type="checkbox"/> Environmental <input type="checkbox"/> Business <input type="checkbox"/> Education/Training <input type="checkbox"/> Safety <input type="checkbox"/> Color Tolerancing <input type="checkbox"/> Sustainability <input type="checkbox"/> Quality <input type="checkbox"/> Other (please be specific): _____	
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What would you suggest to improve future meetings?

What topics would you like to see covered in future meetings?

Are there other sponsorship opportunities to pursue for CAD RETEC® (like receptions, breaks, etc.)?

Please use the space below to describe how SPE CAD can improve your membership value? What can we do new or different?

Drawing Entry – Submit by noon Wednesday, September 17th at the Registration Desk or CAD Tabletop

Name: _____

Company: _____

Phone: _____

e-mail: _____

Would you consider a position on the CAD Board of Directors?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Would you be willing to present a paper at a CAD RETEC®?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Would you like to submit an article for the CAD Newsletter?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Would your company be interested in becoming a sponsor for a future CAD RETEC®?	<input type="checkbox"/> Yes <input type="checkbox"/> No

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Society of Plastics Engineers
Color & Appearance Division
Endowment Scholarship Program
for the 2026 – 2027 School Year



The Endowment Scholarship Program offered by the Color & Appearance Division of the Society of Plastics Engineers awards multiple scholarships each year to students who have demonstrated or expressed an interest in the coloring of plastics industry. The students must be majoring in or taking courses that would be beneficial to a career in this industry. This would include, but is not limited to, plastics engineering, polymer science, coloring of plastics, chemistry, physics, chemical engineering, mechanical engineering, industrial design and industrial engineering. All applicants must be in good standing with their colleges. Financial need is considered for most scholarships.

Undergraduate and graduate scholarships have ranged up to \$8,000 annually. Scholarships are awarded for one year only, but applicants may apply for a re-award for each year they are enrolled in school.

Scholarship Eligibility

1. Applicants for these scholarships must be full-time undergraduate students in either a four-year college or a two-year technical program or enrolled in a graduate program.
2. All applicants must be graduates of public or private high schools.

Scholarship Criteria

1. Applicants must have a demonstrated or expressed interest in the coloring of plastics industry.
2. Applicants must be majoring in or taking courses that would be beneficial to a career in the coloring of plastics industry.
3. An applicant must be in good academic standing with his or her school.
4. Preference is given to student members of SPE and also to students who have a parent(s) as a member of the Color & Appearance Division of the SPE.
4. Financial need of an applicant will be considered for most scholarships.

Application Procedure

To be considered for a scholarship from the Color & Appearance Division Endowment Scholarship Program, applicants must complete an on-line application in the Spring of 2026. Check www.specad.org for deadlines and for any additional updates to the process. All applications submitted must include:

1. A completed application form.
2. Three recommendation letters: two from a teacher or school official and one from an employer or non-relative.
3. A high school and/or college transcript for the last two years.
4. An essay by the student (500 words or less) telling why the applicant is applying for the scholarship, the applicant's qualifications, and the applicant's educational and career goals in the coloring of plastics industry.

For more information, visit www.specad.org or contact Ann Smeltzer at (412) 298-4373 or e-mail at ann.smeltzer@sudarshan.com

All scholarships will be paid directly to the recipients' schools. Schools must reside in the US and all funds are paid in US funds. The Color & Appearance Division Endowment Scholarship Program will not award scholarships to applicants who are not qualified and reserves the right to not award a scholarship in a given year if it so chooses.

TECHNICAL ARTICLE INTRODUCTION

CADNEWS TECHNICAL CONTENT

The Technical Content portion of this edition of CADNEWS® includes a paper presented during the recent RETEC. The paper by Paul G Anderson of Coperion, highlights the optimization of twin screw extrusion for processing color masterbatch. The paper, FUNDAMENTALS OF TWIN-SCREW EXTRUSION COLOR MB PROCESSING: COMMON PITFALLS & HOW TO AVOID THEM. Take a moment to read and as always if you have any questions you can ask any questions using the Color Notes Link below.

CADNEWS COLOR NOTES

Welcome to CADNEWS® Color Notes. Do you have a question regarding color and effects? Don't miss your opportunity to anonymously ask our team of experts. We can help create discussion as well as provide answers. Color, appearance, color measurements, and colorants in general are all in our scope. Use the link below to submit your questions. Our SPECAD Color Notes committee will provide a response in the upcoming CADNEWS®.

[HTTP://SPECAD.ORG/COLOR-QUESTIONS-FOR-CAD/](http://SPECAD.ORG/COLOR-QUESTIONS-FOR-CAD/)

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**FUNDAMENTALS OF TWIN-SCREW EXTRUSION
COLOR MB PROCESSING: COMMON PITFALLS & HOW TO AVOID THEM**

Paul G. Andersen, Coperion Corporation, Ramsey, NJ

Abstract

The process for compounding color masterbatch formulations is comprised of several unit operations. These typically include, but are not limited to: feedstock introduction, polymer or polymer/pigment melt-mixing, distributive/dispersive mixing of pigments/minerals/additives, removal of volatiles, and pressurization for die discharge. While each unit operation has an impact on process productivity and quality of the finished product, melt-mixing often has a significantly greater impact than the others. First, it consumes 50, 60 or higher percent of the total system energy. Second, it generates the highest radial as well as particle-particle interactive pressure of any unit operation. Third, the negative impact on the process of any screw design flaws in the melt-mixing configuration is transmitted downstream to all subsequent unit operations. For example, a melt-mixing design that is too intense may degrade a heat or shear sensitive polymer/organic pigment/additive pre-blend, while one that is too weak may result in insufficient melt/mixing of the pigment or mineral. Another example of the impact of an incorrect melt-mixing configuration would be excessive abrasive wear. It is also possible to have adhesive wear. This results from the generation of high radial forces that cause the screw elements to rub directly on the barrel wall. Additionally, non-melting material such as pigments or minerals like TiO₂ that are introduced along with the polymer during the melt-mixing process could be compacted into “briquettes” by the high radial pressure. The “briquettes” would then have to be dispersed by subsequent downstream unit operations. Other potential issues associated with a non-optimal melting section are pre-mature melting and incomplete melting. The former is more of a concern with melting of powder feed stock while the latter is more probable with feed stock blend comprised of materials with a broad range of melting points. However, the consequence of both is to convey un-molten polymer beyond the melting section.

This presentation provides a further discussion of the issues noted above as well as associated examples.

Introduction

In order to design the “optimal” screw configuration for polymer melting, one needs to address more than the kneading block configuration in the “melting section”. First, polymer characteristics need to be identified. This includes more than just knowing the enthalpy curve. The physical form of the feedstock is also important. For example, is the polymer a powder, granule or pellet? Is the physical dimension of the polymer feedstock uniform? In addition to knowledge about the polymer, understanding process interactions of additional components can be critical. Are there materials such as stabilizers or mineral filler being introduced along with the polymer? Is there material being introduced downstream? What are the characteristics of these materials? Do they melt? Are they pellet, powder, fiber etc.? The above are a few of the key questions the designer needs to address before going forward with developing a screw configuration. If these are not considered, then the screw configuration may be subject to one of the common pitfalls reviewed next.

Polymer Feed Characteristics/Geometry

The physical form of the polymer/polymer MB premix has a significant impact on the location of the melting zone relative to the feed barrel, as well as the screw configuration in the conveying section. In general the typical 3.0 mm pellet is easy to feed and causes no problems, but as the polymer or premix particles get smaller there are several issues that can develop. Figure 1 depicts two of these potential issues. First, as the upper right side graphic illustrates, the finer the particle size the further the melting section needs to be moved downstream, i.e. increase the conveying distance L, to avoid the potential for back up into the feed throat. This is the result of a greater percentage of air being introduced with the polymer as the particle size is reduced. This air is forced back toward the feed throat as the powder is compressed prior to entering the melting section. The countercurrent air flow fluidizes the powder in the screw channel and reduces the conveying efficiency of the elements. In the worst case scenario it will cause a backup into the feed throat, and thus the required production rate will not be achieved. As a consequence the rate per rpm is lower, this in turn means that the specific mechanical energy and the associated melt temperature are higher, and the potential for degradation of the polymer or additives is increased. Alternatively, if the restrictive element at the end of the melting section, most often a left handed (LH) kneading block, is too strong then the fluidized powder can also back up toward the feed throat. However, as will be discussed in the next section, this back up can result in significant melting issues even if the material does not back up all the way to the feed throat. Therefore, especially for powder feeds, the designer must pay attention to the location and design of the melting section.

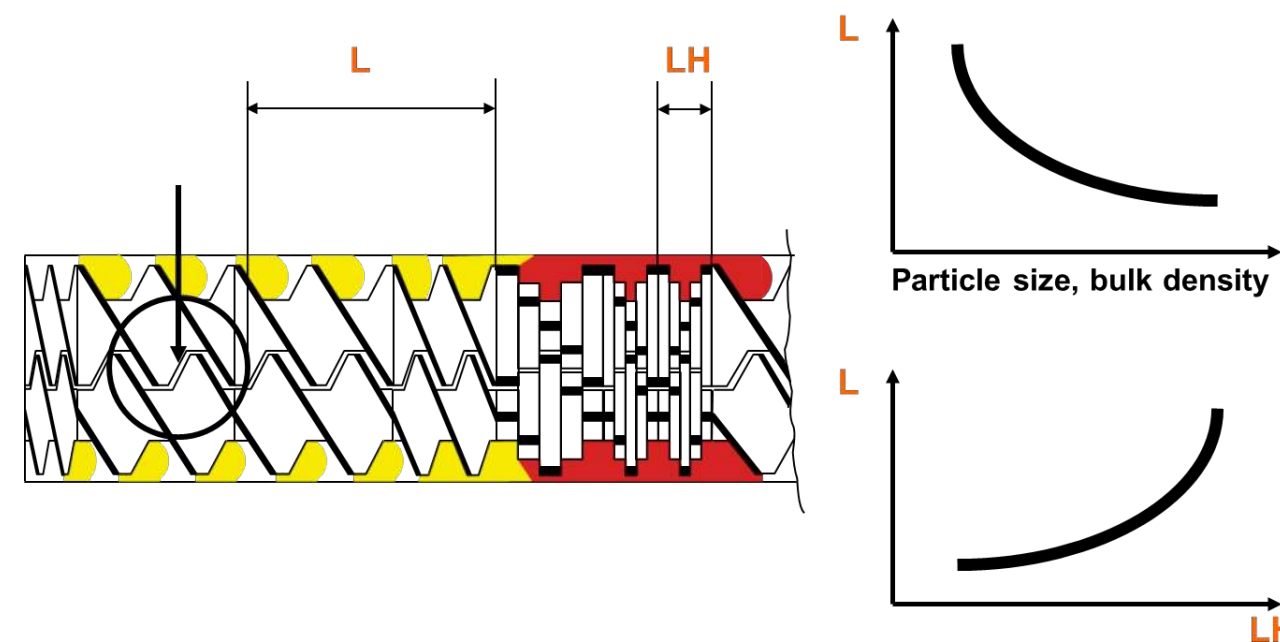


Figure 1: Conveying zone length as function of feedstock particle size

An additional caution for working with powder feeds is the potential for melting in the conveying elements prior to the kneading block melting section. This phenomenon is illustrated in Figure 2. The powder is pressed against the barrel wall and starts to melt, but because it is still in the conveying section, the layer of melted polymer is forced to flow around the outer border of the screw channel and encapsulate large aggregates of the polymer powder. The encapsulated aggregates are reduced in size by the kneading blocks of the melting section but some aggregates are still able to follow a low shear path through the kneading blocks and flow downstream. This problem is typically observed if the screw element prior to the first kneading block is too small a pitch, Figure 3 (left side). This adds additional

compression of the powder against the barrel wall, which in turn enhances the probability for pre-mature melting.

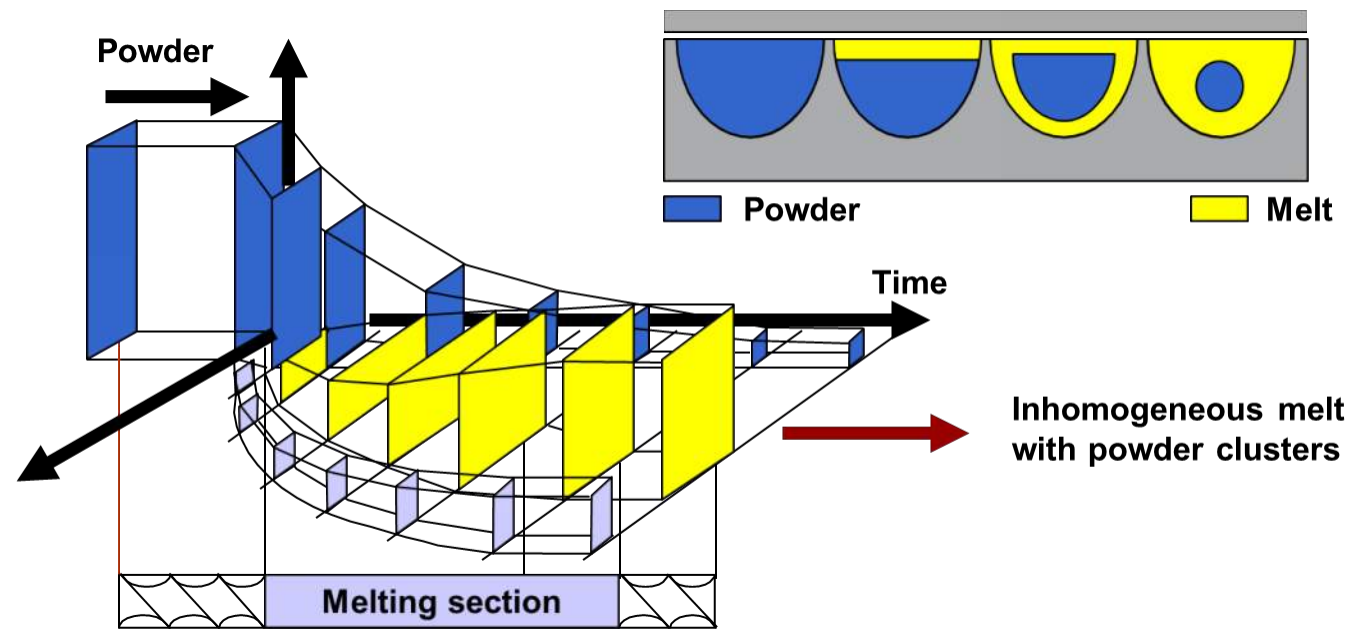


Figure 2: Pitfall: Premelting in Screw Bushings

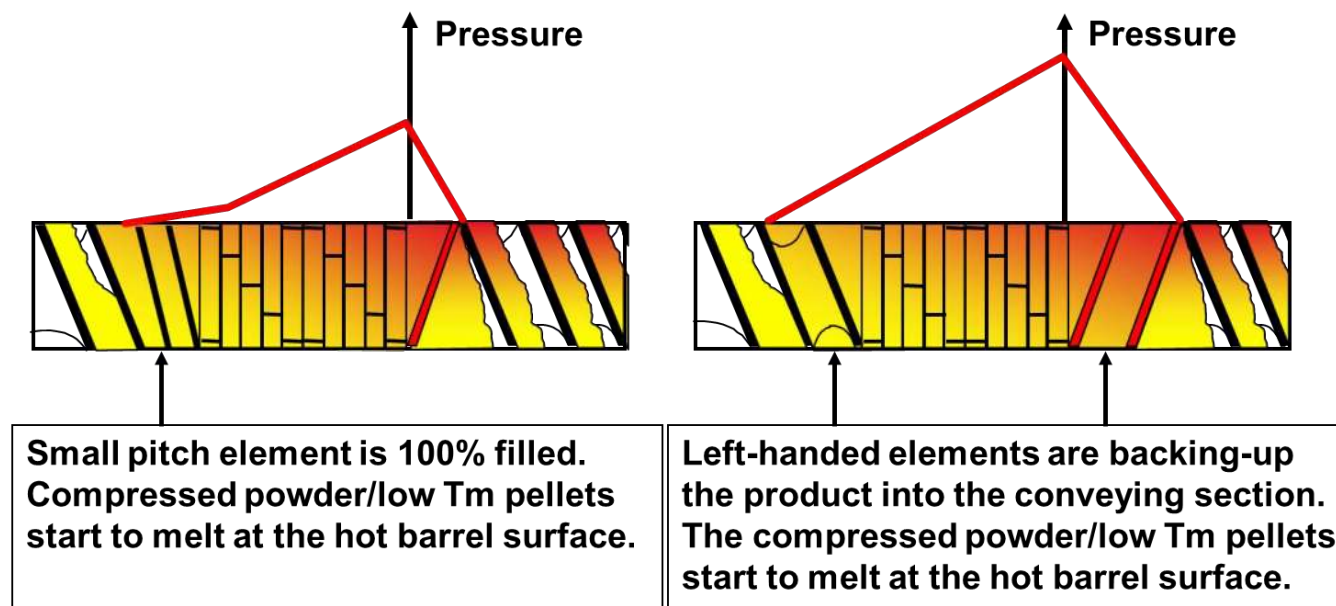


Figure 3: Pitfall: Material Back up in Screw Bushing

Another design pitfall is to make the restrictive elements at the end of the melting section too aggressive, Figure 3 (right side). This can also cause the powder to back up into the conveying elements. As illustrated in Figure 4, the ideal melting section initiates plastification in the first kneading block where the initial polymer melt is immediately mixed with the unmolten material, thus avoiding large aggregates of encapsulated powder.

Even if there is no melting, backing up polymer powder in the conveying elements prior to the kneading block melting section, especially if the powder is a blend with an abrasive filler such a calcium

carbonate, can have a negative impact on the process economics. Figure 5 shows conveying elements upstream of the 3-lobe kneading block melting section that have experienced significant abrasive wear. This is indicated by the narrowing and rounding of the element crests for 2 revolutions upstream of the melting section and the root diameter being worn through to the shaft approximately one revolution upstream. The addition of a special conveying type kneading block as the first element in the melting section would have alleviated much of the wear in these screw bushings.

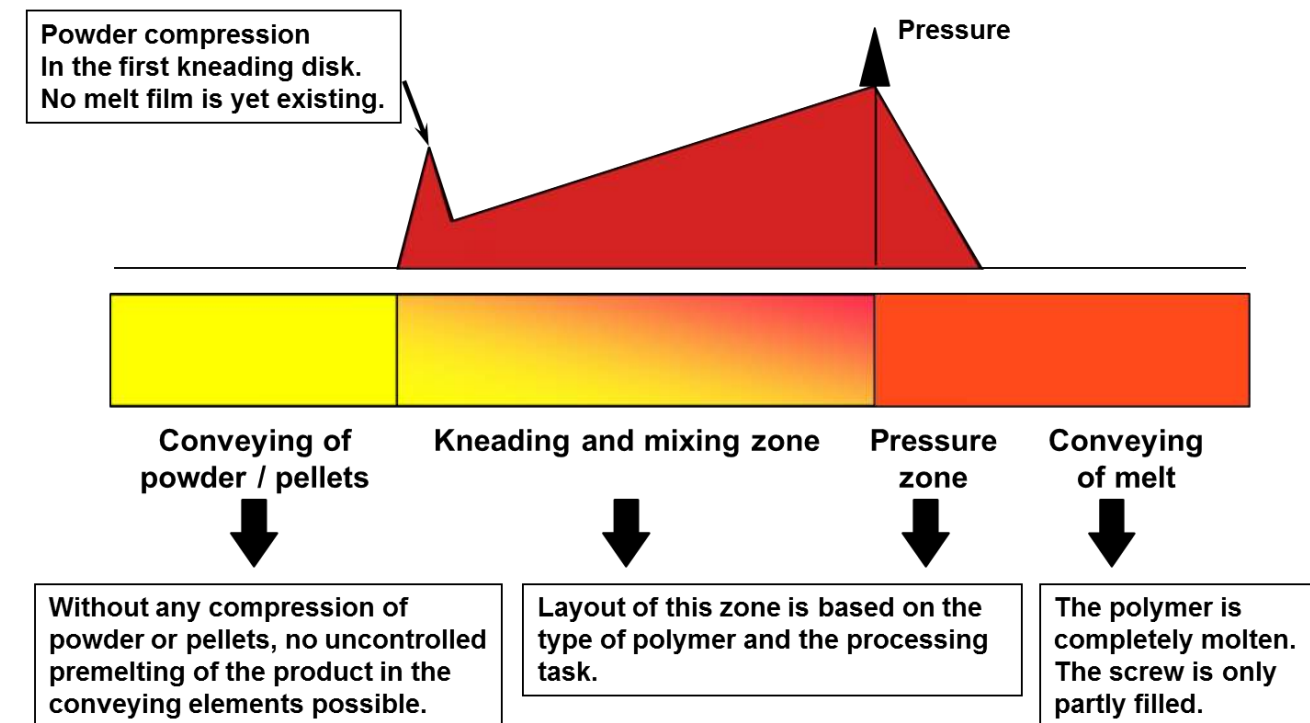


Figure 4: Optimal Layout of Melting Zone



Figure 5: Wear due to back up into screw bushings. Flow direction left to right.

Influence of Kneading Block (KB) Configurations

It was illustrated in the previous discussion that an improperly designed melting section can have a significant negative impact on the feed intake and the solids conveying unit operation from both a process performance and machine wear perspective. Additionally, an improperly designed kneading

block sequence in the melting section can have a negative impact on the quality of the melt/mixing and dispersion of pigment/filler in the polymer. It can also have a significant impact on element and barrel wear.

Figure 6 summarizes results from a paper by Rogers et al. (1). Five melting configurations were evaluated for melt mixing an 85/15 wt% PC/CaCO₃ blended feedstock. The compounded material was analyzed for agglomerates. The data provides the basis for the hypothesis that in addition to not breaking down aggregates, the choice of a non-optimal sequence can actually create agglomerates that then have to be broken apart later in the process. For example, the sequence at the far left is comprised of a wide disc (length is 1.5 times screw diameter) forwarding type KB followed by a medium disc forwarding KB (1 diameter long) and a full turn of reverse flow screw elements. The wt % of agglomerates for this 2-lobe KB sequence is significantly higher than the corresponding wt % agglomerates associated with the other 4 sequences that begin with a three-lobe kneading block. This difference can be explained by data in Figure 7.

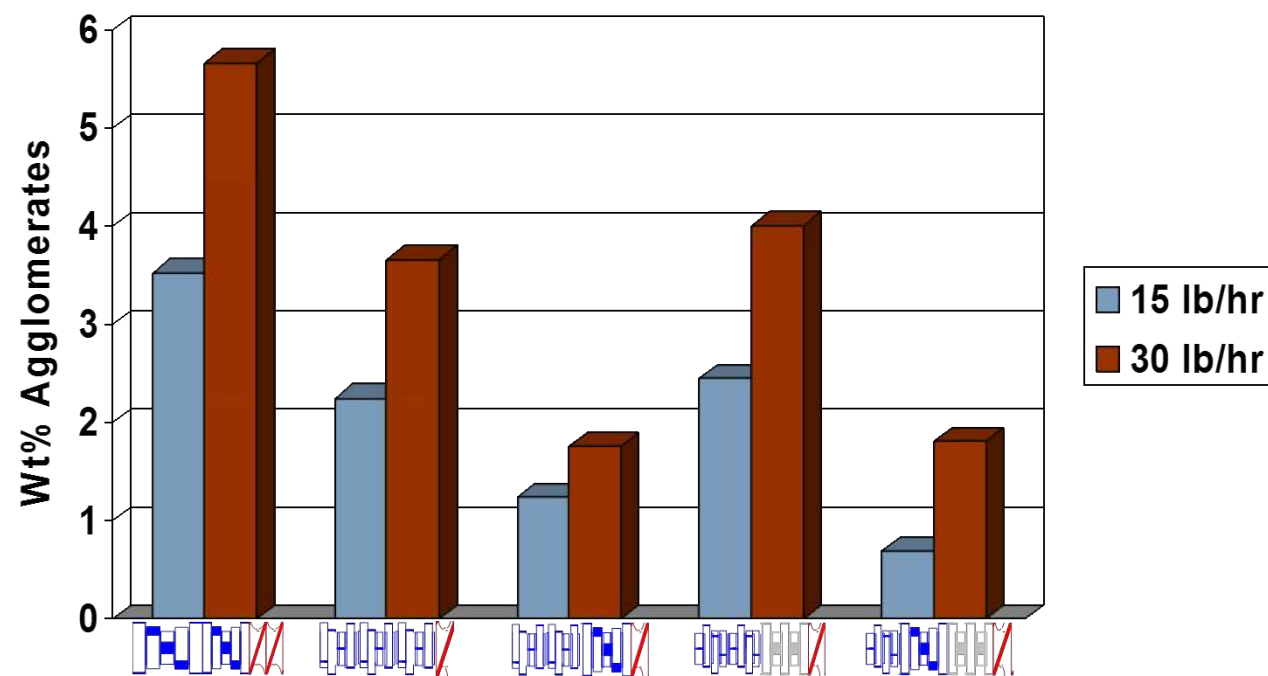


Figure 6: Impact of kneading block configuration on agglomerate content

Figure 7 shows a comparison of pressure and torque plots in the polymer melting zone for a 2-lobe and 3-lobe kneading block sequence. First, as shown on 2 plots in the center of the Figure 7, the apex pressure of the 2-lobe wide disc kneading block at the point of initial melting is roughly 3 times that of the 3-lobe kneading block. This 3x compressive pressure differential can provide sufficient additional force to agglomerate non-melting feedstock components during the melting process. The amount of agglomeration depends on the characteristics of the individual materials. Additionally, the plot on the right side of the figure illustrates a more subtle but still significant difference. The torque on the screw shaft is more stable with the 3-lobe kneading block. In this figure, the 3-lobe element exhibits a mild undulation as compared to the cyclic swing of the 2-lobe KB.

To further illustrate the point, note that the sequence (Figure 6, configuration 2) with only 3-lobe kneading blocks is not sufficient to obtain the best dispersion value. The third and fifth configurations (going left to right in Figure 6) which use a 1 diameter forwarding KB after the 3 lobe kneading blocks

show a significant reduction in agglomerates. These 3 sequences indicate that the 3-lobe kneading blocks will melt the matrix material but require the dispersive characteristics of the wide disc 2-lobe kneading blocks to break down the inherent, as well as any in-situ formed, aggregates. The fact that sequence 5 shows better results than sequence 3 further indicates that the 2-lobe kneading blocks are effective dispersive units once a melt or at least a partial melt has been established. Based on these three configurations it could be summarized that best dispersion results are obtained when the initial melting is initiated by the 3-lobe kneading blocks, but completed by traditional 2-lobe kneading blocks.

However, configuration 4, which sequences directly from the 3-lobe kneading blocks into a neutral KB before the LH screw bushing at the end, has worse dispersion. This is most likely the result of this sequence being too restrictive. The 3-lobe kneading blocks are not very effective forwarding elements. Therefore when sequenced with a neutral/LH element combination, just as illustrated previously in Figures 2 and 3, the polymer starts to melt prior to the KB section which results in inefficient melting and, in this situation, insufficient dispersion.

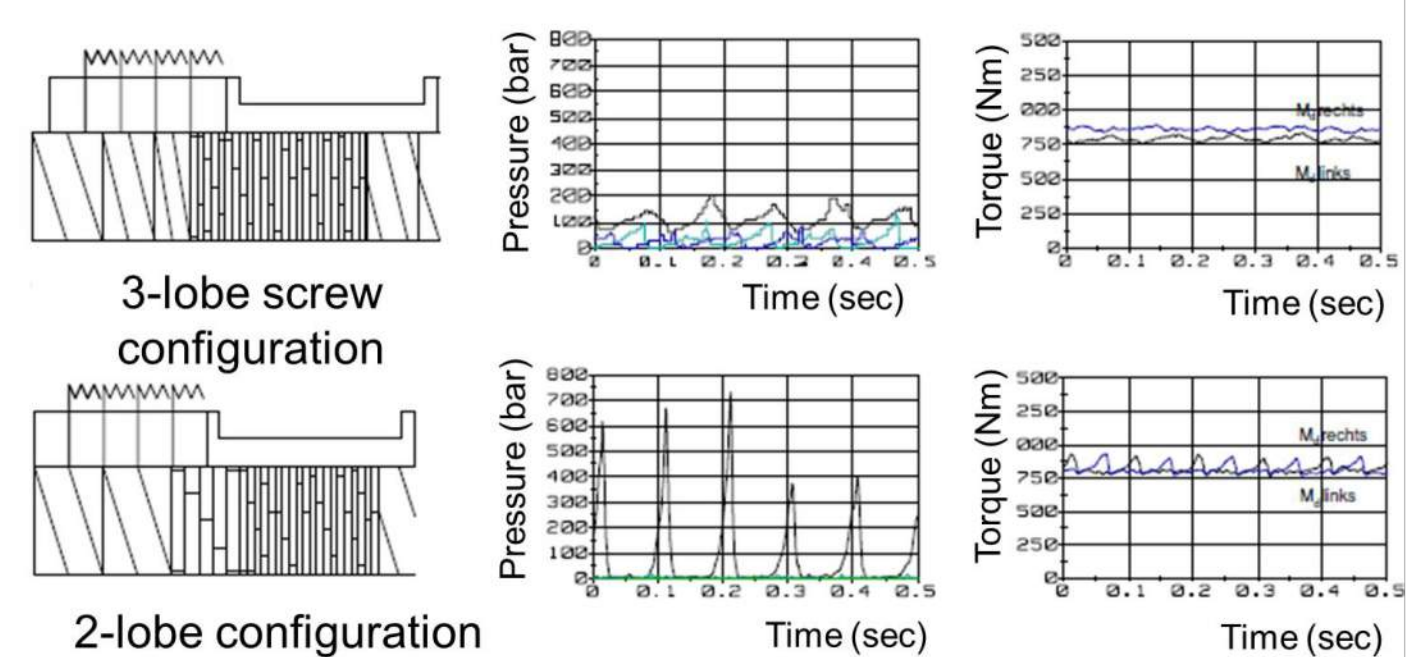


Figure 7: Pressure vs. time profile for 3-lobe vs. 2 lobe kneading block geometry

Figure 8 illustrates the geometry of the 3-lobe kneading block and the basis for the reduced forward conveying capacity as well as the significantly lower pressure in the apex shown in Figure 7. The left illustration depicts the end view of the element. It shows that two of the three tips of the element have a larger gap than the third tip. This enhances the opportunity for material to flow over the tip and not be conveyed downstream, thus reducing forward conveying efficiency. When the material encounters the third tip which has the standard width gap, it is conveyed downstream. This is further illustrated on the right side with the unwrapped profile. Additionally, the larger gap between the element tip and barrel wall minimize material compression which is the basis for the 3-lobe kneading blocks displaying much lower and more uniform pressure in the apex of the extruder barrel, Figure 7. In summary, the geometry of the three lobe kneading block elements do not create, or at least reduce the creation of agglomerates as compared to wide disc kneading blocks. On the other hand, this geometry is not the most efficient for dispersive mixing. The best performance is obtained with an optimal sequencing of both 3-lobe and 2-lobe kneading blocks,

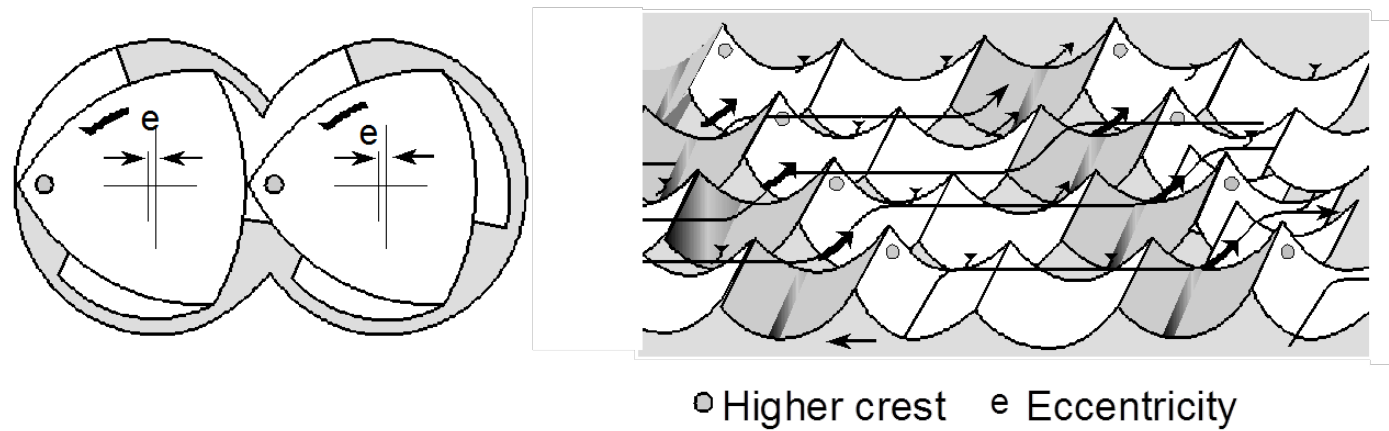


Figure 8: Operating principle of 3-lobe kneading blocks

Another example of the benefit of choosing a 3-lobe kneading block vs. 2-lobe kneading block melting section is illustrated in Figure 9. In this case there is no compactable material to form agglomerates but rather a heat and shear sensitive polymer, acetal (polyoxymethylene), that will decompose at a temperature (~235-240 °C) not much above the melting point of the polymer. The top configuration of forwarding geometry 2-lobe kneading blocks followed by a single restrictive kneading block is limited by material temperature to a screw speed of 250 rpm vs. a screw speed of 500 rpm for the bottom screw design composed of all 3-lobe kneading blocks.

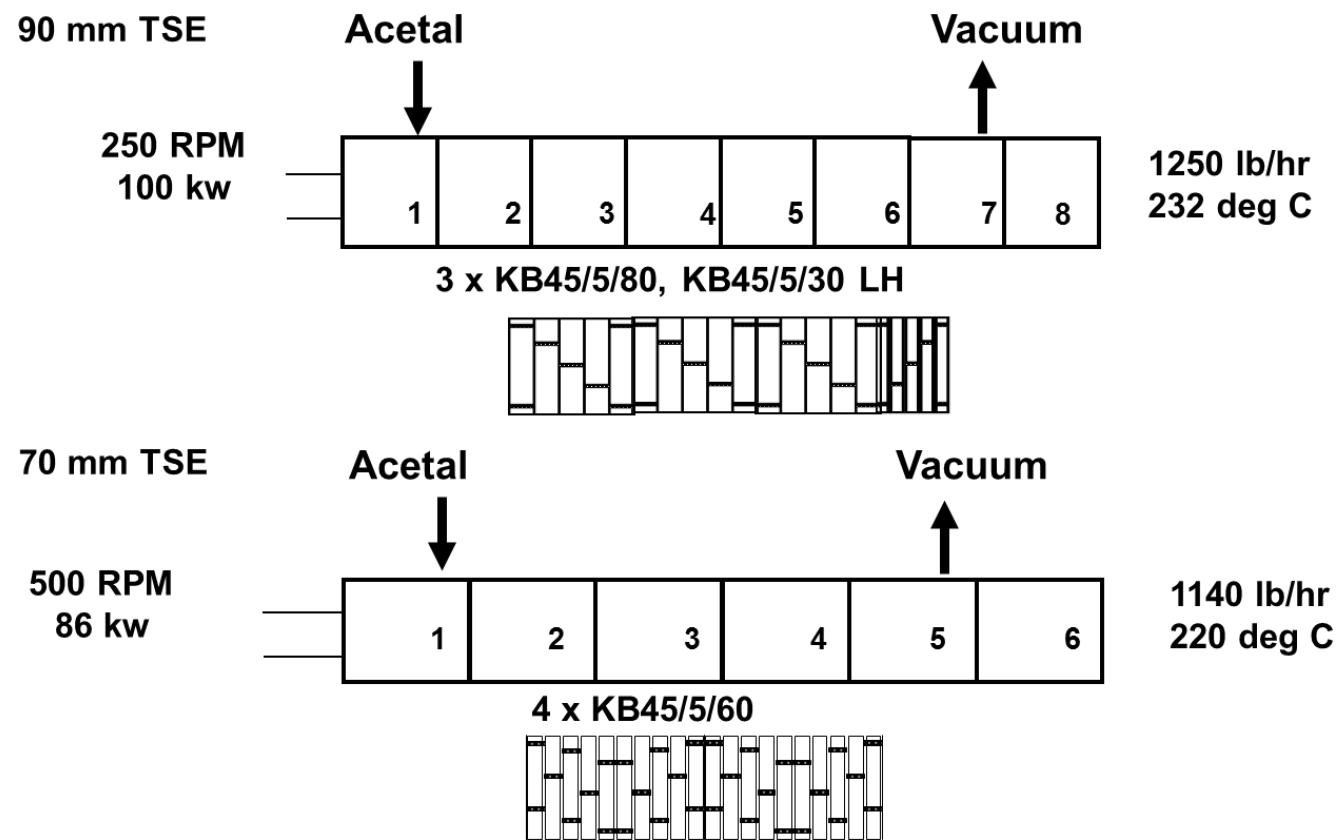


Figure 9: Melting Acetal: 2-lobe vs. 3-lobe KB configuration

Influence of Machine Geometry

In addition to feedstock form (powder vs. pellet) and screw configuration (feed conveying length, kneading block geometry, kneading block sequencing etc.) extruder geometry, i.e. diameter can have a significant impact on the melting process. The smaller the extruder, the more probable it becomes that melting is unduly influenced by heat transfer from the barrel heaters. Figure 10 shows a comparison between installed heater unit kW vs. installed motor kW at 300 rpm for the ZSK Mc series of extruders. Above 40mm, the motor kW significantly exceeds the installed heater power, but at 40 mm the two cross over. For a lab extruder in the 20 and 30 mm diameter range, the available heater shell power is greater than the motor power. The significance of this crossover is that if polymer melting is enhanced by external heater unit kW, the recorded Sme (specific mechanical energy) may be lower than actual. This could negatively impact scale up results.

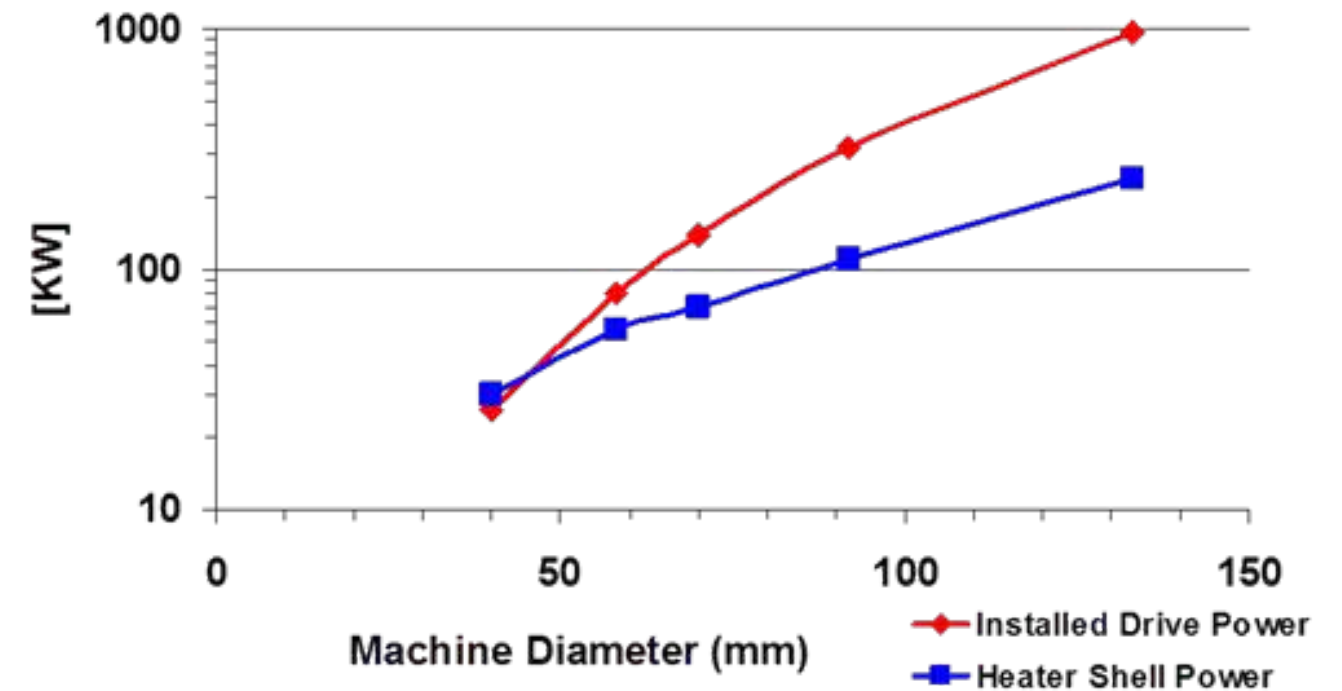


Figure 10: Installed heater vs. drive power at 300 rpm for ZSK Mc series

Cooling, while not really part of a discussion on melting, should be mentioned as this section is about heat transfer. Therefore it needs to be noted, that while small diameter units can draw a significant amount of their energy from external heaters versus their motor power, they can also remove an inordinate amount of energy through the barrels. This energy is removed either through a medium such as water or simply by radiant cooling. The consequences of excess heat removal through the barrel walls can be multifold. One is that the attainable discharge temperature is lower on the small diameter lab line relative to the production unit. Another can be better pigment dispersion due to lower processing temperature. This keeps the matrix viscosity higher which in turn results in better stress transfer and ultimately better dispersion. While a higher discharge temperature may be able to be tolerated on a commercial unit as long as there is no product degradation, poorer dispersion on the commercial line could result in reduced physical properties, but more significantly, a color shift.

Summary

To avoid melting pitfalls:

- 1) Optimize melting zone location relative to feed opening
 - a. The smaller the particle, the greater the distance
 - b. The more intense the restriction at the end of the melting section, the greater the distance.
- 2) Use the appropriate kneading block configuration
 - a. Design for process objective
 - b. Make it long enough to avoid premature melting in the conveying section
 - c. Use 3-lobe kneading blocks for the most uniform melting
 - d. Avoid high radial pressure generating elements with compactable feedstock.
- 3) Run lab/pilot unit as close to adiabatic as possible

References

1. M. Rogers *et al.*, SPE ANTEC Proceedings, 129 (2001)

Key Words: Twin-screw, compounder, melting, masterbatch



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jeffrey.drusda@chemours.com

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Steve@paramountcolors.com

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coachingwithpassion@proton.me

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Karen Carlson, 912-604-3537
SUSONITY
karen.carlson@susonity.com

Brian Coleman, 410-708-8758
Ampacet
Brian.Coleman@ampacet.com

Josh Jacobs, 419-575-4806
Uniform Color
Joshua.Jacobs@audia.com

Jack Ladson, 267-981-7112
Color Science Consultancy
jack@ColorScienceConsultancy.com

Mercedes Landazuri, 773-988-0857
Ampacet Corporation
mercedes.landazuri@ampacet.com

Bruce Mulholland, 859-982-5256
Celanese (Retired)
captcolour@gmail.com

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Trust Chem USA
michele@trustchemusa.com

Eric Duncan, 330-618-4143
Akrochem Corporation
EricDuncan@Akrochem.com

Jim Figaniak, 215-768-0769
Lehvos North America
jfiganiak1028@gmail.com

Mike Manley, 765-542-9448
Holland Colours Americas, Inc.
mmanley@hollandcolours.com

Alex Prosapio, 845-641-0506
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