



# SAPPMA

southern african plastic pipe manufacturers association

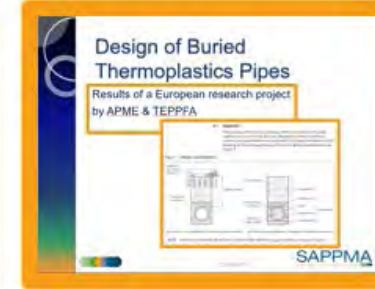
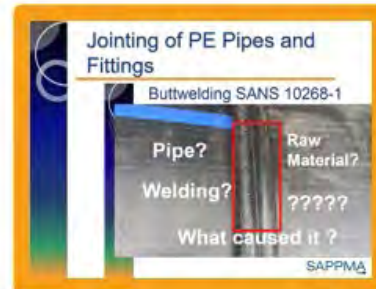
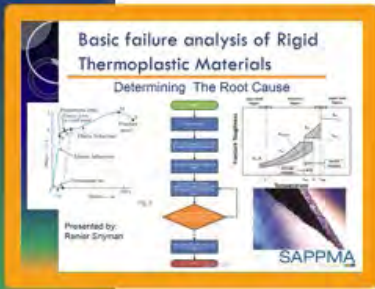


November 2021

## WEBINAR IX



# SAPPMA Webinar I to VII on SAPPMA Web site



# Recent CPD training event

IFPA  
21-10-2021

CPD Continued Professional Development



Focus Drives Outcome



SAPPMA  
4

IFPA  
21-10-2021

**Thermoplastic Pipe Systems:**  
Important aspects to understand and keep in mind during design and specification

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www.sappma.co.za

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IFPA  
Institution for Professional Practice  
The Association

SAPPMA  
3

We Hope to See You at the Next Event

# What is your formula to success ?



### Arithmetic Operators

+	
-	
*	
/	
//	
%	
**	

A=10	
B=20	
C=A+B	
D=A-B	
E=A*B	
F=A/B	
G=A//B	
H=A%B	
I=A**2	

30
-10
200
0.5
0
10
100

Did you factor in the unknowns?

Are you Rigid or Flexible?

How does it compare to what we know?

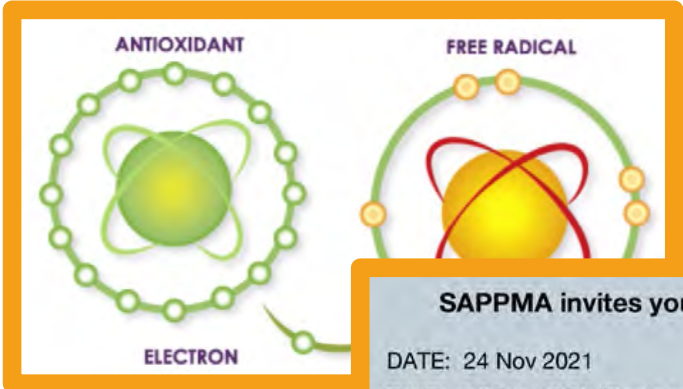
Does it all add up?



# (Critical to Quality) CTQ & CTS (Critical to Success)




# SAPPMA Webinar IX



**SAPPMA invites you to its 9<sup>th</sup> Webinar for 2021**

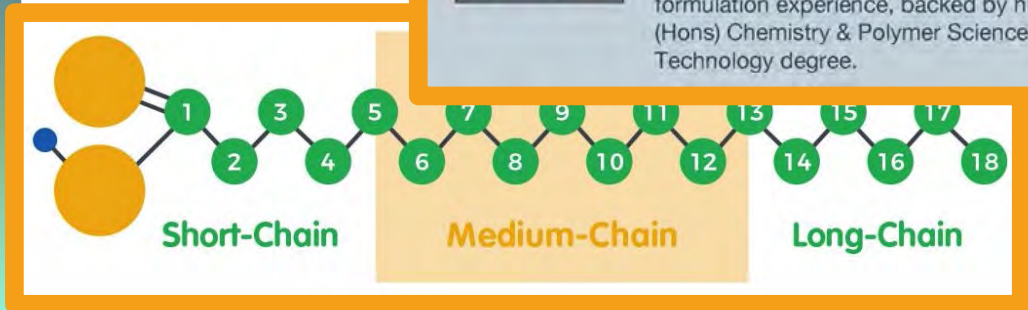
DATE: 24 Nov 2021  
 TIME: 9:00 to 10:30 (Registration from 8:45)  
 PLATFORM: ZOOM

**Gelation of Extruded PVC Pipes:  
 What does it mean, and why is it important?**



Your pipe and fitting compound formulation is at the heart of your operation and drives the success of the organisation and that of the piping system.

Chris Cheeseman, Technical Sales Manager at Akdeniz Chemson Additives Ltd. UK, will share his 30 years of PVC compound formulation experience, backed by his BSc (Hons) Chemistry & Polymer Science Technology degree.



# Presenter

# SAPPMA Webinar IX

24 November 2021



 **Akdeniz Chemson**  
Beyond Additives

**Chris  
Cheeseman**





# Akdeniz Chemson

*Beyond Additives*

Welcome to  
Akdeniz Chemson







● **1942**

Our story began in 1942 Cookson plant in Sydney/Australia.

● **1986**

German manufacturers Chemetall and the English Cookson Group merged. Chemson has born in Frankfurt, Germany.

● **2012-2013**

Akdeniz Kimya joined Turkey's OYAK Group. One-year later, the Chemson Group became part of the OYAK Group as well.

● **1976**

In 1976, Akdeniz Kimya was founded in İzmir, Turkey.

● **2000-2001**

Chemetall moves the stabilizer business of its Brazilian subsidiary Chemetall to Brasil to the new company & in 2001 Chemson enters the Chinese market.

● **2020**

Two strong brands merged into Akdeniz Chemson, and become the world market leader in PVC stabilizers.

 **Global manufacturer of the World!**



# Partnership with :

## **Associated Additives**

- **Manufacture and supplier of Lead and non-lead based products into mining, battery, PVC and chemicals industry worldwide.**



### Product Range

- Organic Lead, Calcium/Zinc, Barium/Zinc and Tin Based PVC-Stabilizers
- Processing aids and Impact Modifiers
- Calcium, Magnesium and Zinc stearates
- Internal and External Lubricants
- Plasticizer/Plasticates (both Lead and Non-Lead)
- Flame Retardants
- Calcium, Arsenic and Gold-free Litharge
- Titanium Dioxide
- Red Lead

Price list only & Confidential

Beyond Additives

# PRODUCTS

### Stabilizers

Ca/Zn & organic stabilizers  
Pb based stabilizers



[Details](#)

### Metallic Soaps

Ca, Zn, Mg, Al based metallic soaps



[Details](#)

### Co-stabilizers

SBM, DBM, CaAcAc, ZnAcAc, Hydrotalcites



[Details](#)

### Lubricants

PE and Oxidized PE waxes, Paraffin Waxes, Ester Waxes



[Details](#)

### Acrylic Impact Modifiers



[Details](#)

### Acrylic Processing Aids



[Details](#)

### Plasticizers

Benzoate based plasticizers



[Details](#)

### Flame Retardants

Zn Borate



[Details](#)

### Anti-Corrosive Pigments

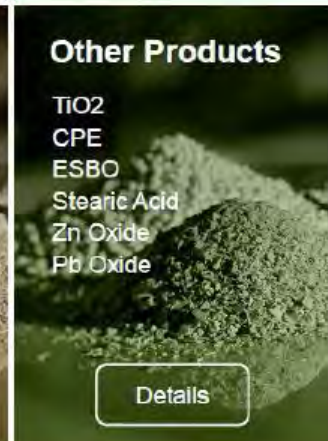
Zn Phosphate



[Details](#)

### Other Products

TiO2  
CPE  
ESBO  
Stearic Acid  
Zn Oxide  
Pb Oxide

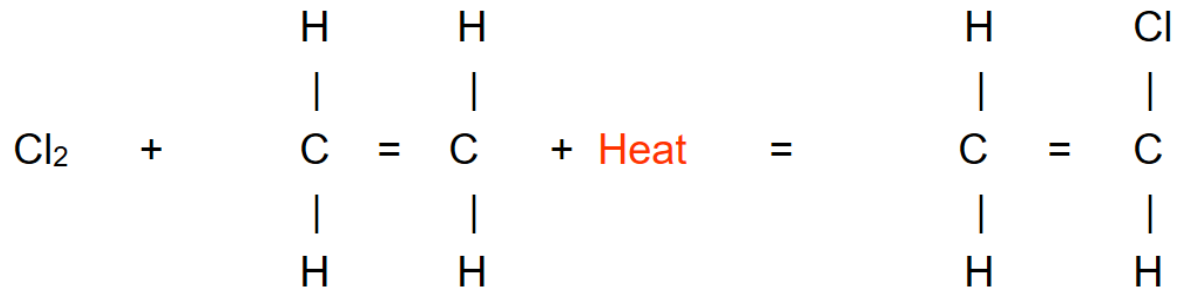


[Details](#)

# What is S PVC?

PVC is manufactured from two of the earth's natural resources – Salt and Oil.

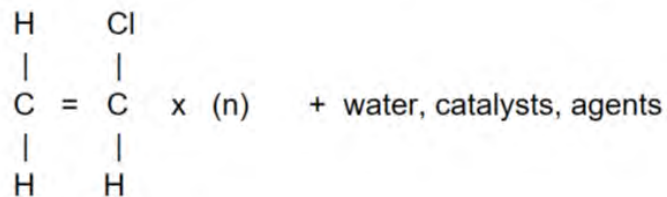
Salt provides the chlorine / Oil provides the ethylene



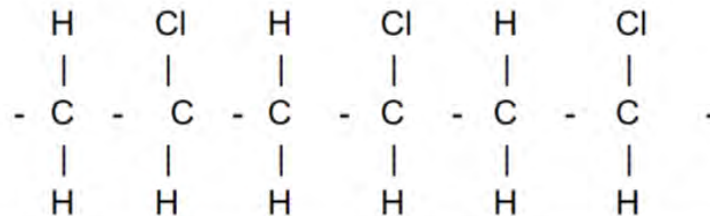
Chlorine + Ethylene + Heat = V.C.M (Vinyl Chloride Monomer)

# What is S PVC?

V.C.M is then mixed with water, peroxide catalyst and suspending agents

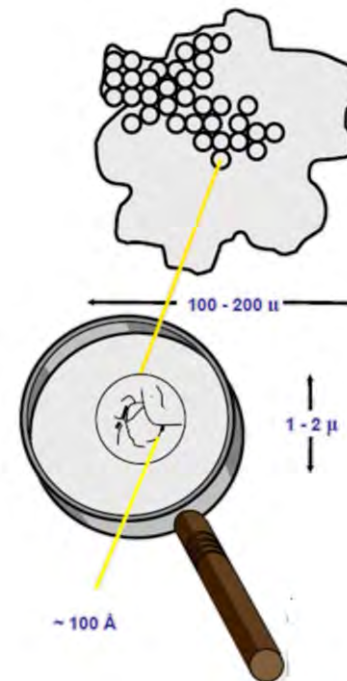
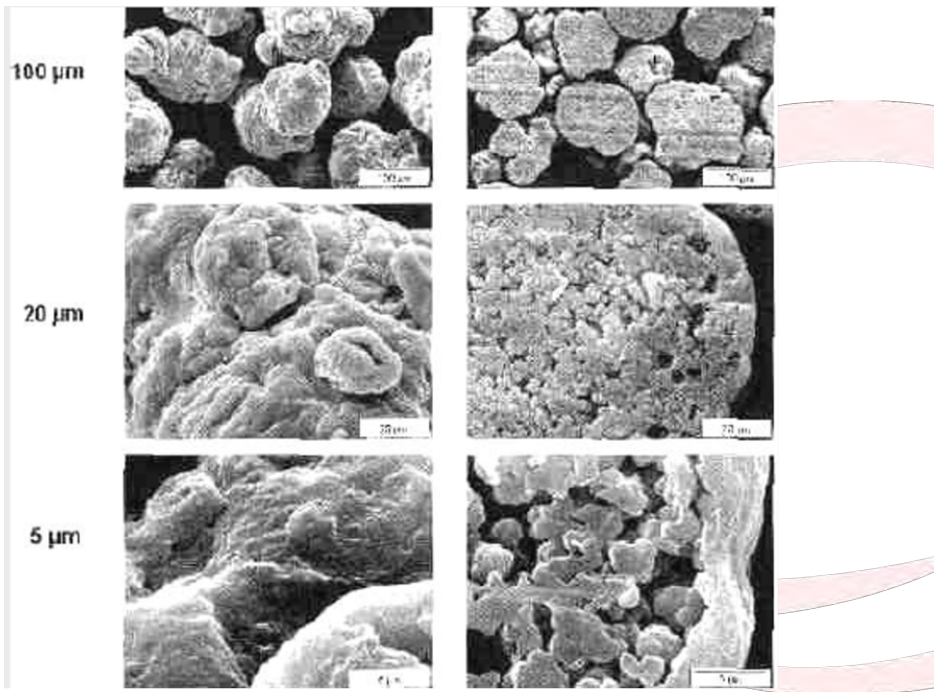


Depending on how long this is reacted a certain chain length/viscosity P.V.C (poly vinyl chloride) is produced.



- > **VCM (Vinyl Chloride Monomer) droplets are suspended in water in the presence of suspension agents.**
- > **Heat and pressure is controlled to determine the chain length, and therefore the viscosity (K value)**
- > **In the presence of a catalyst, chains form within the droplets and remain in the lowest energy state: a ball known as a primary particle.**
- > **Primary particles agglomerate, and a skin is formed around these: These secondary particles are grains of resin**

# What does S PVC look like?



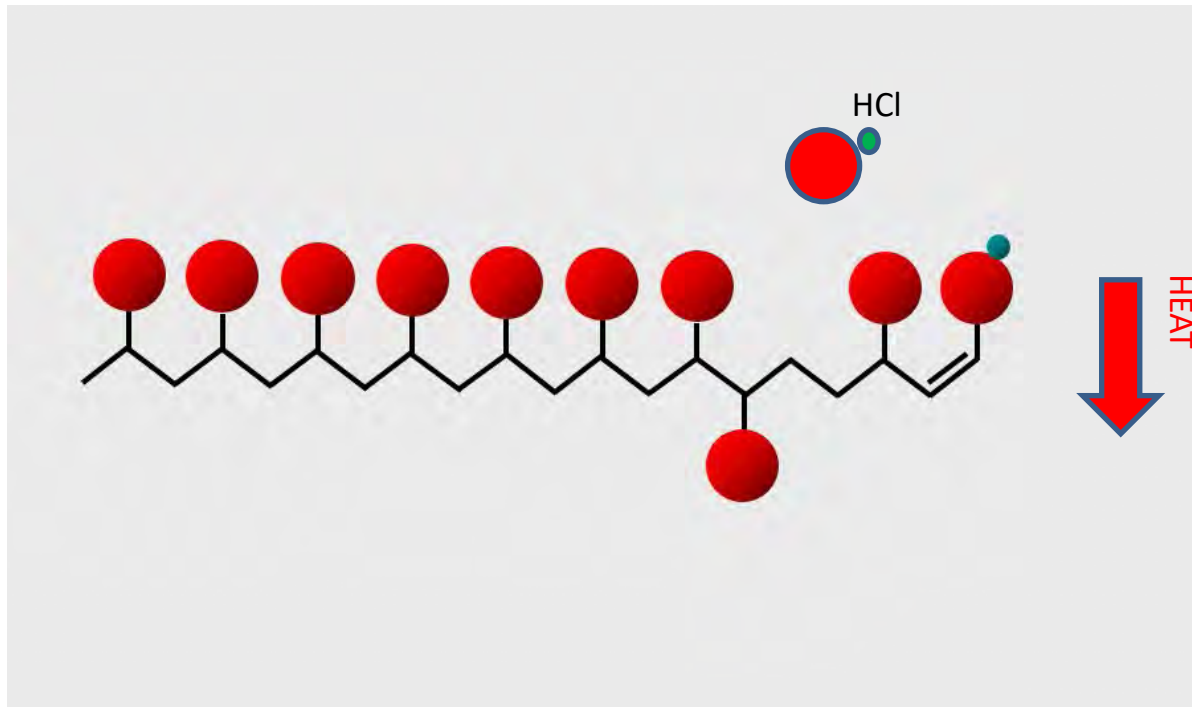


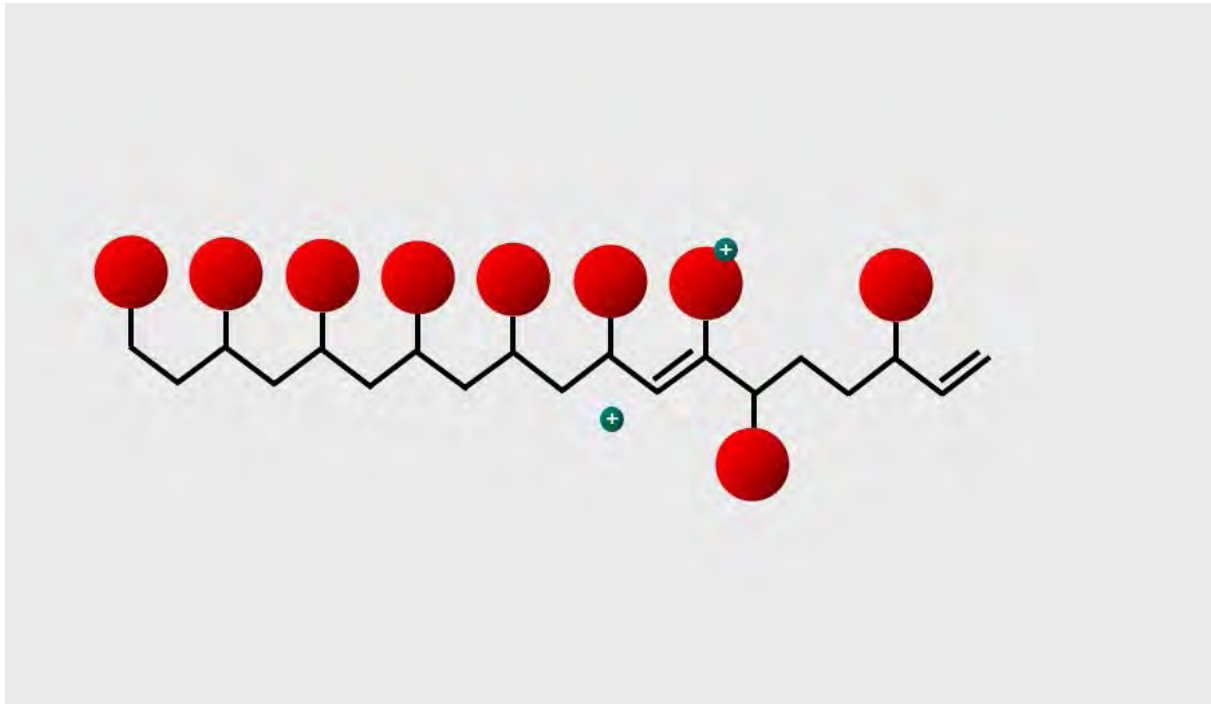
# Why does PVC need stabiliser?

PVC is an unstable polymer (heat/UV/shear) and needs stabiliser to process it

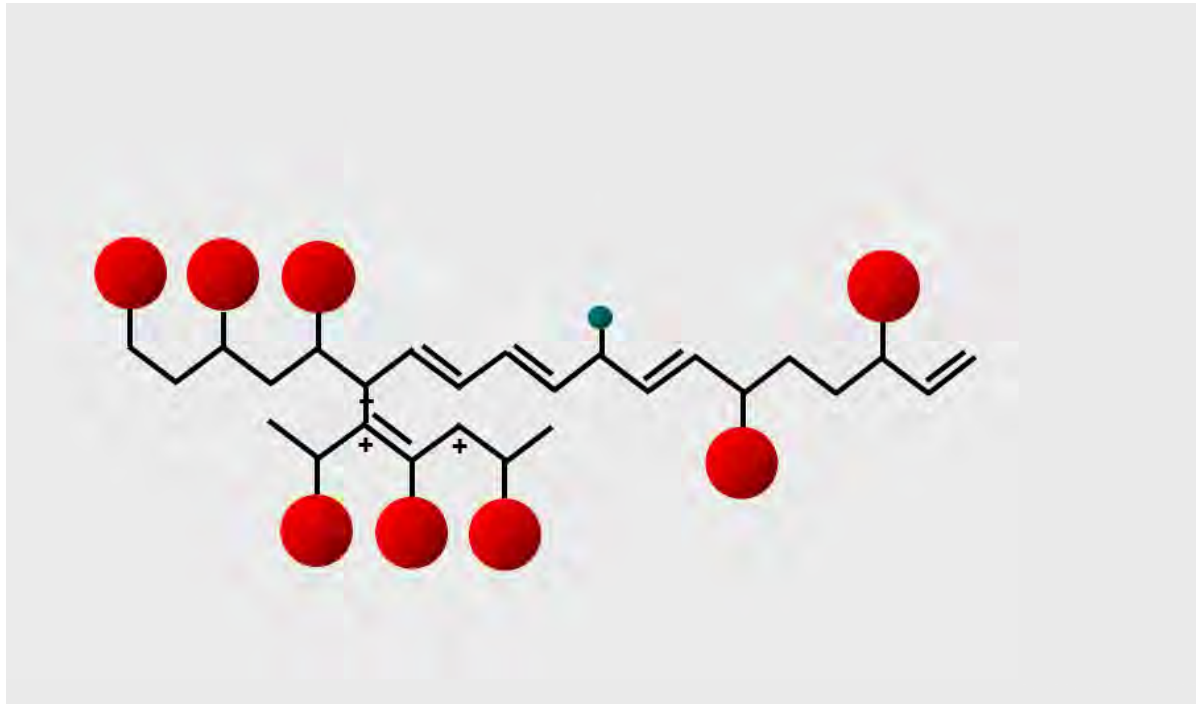


# Degradation of PVC

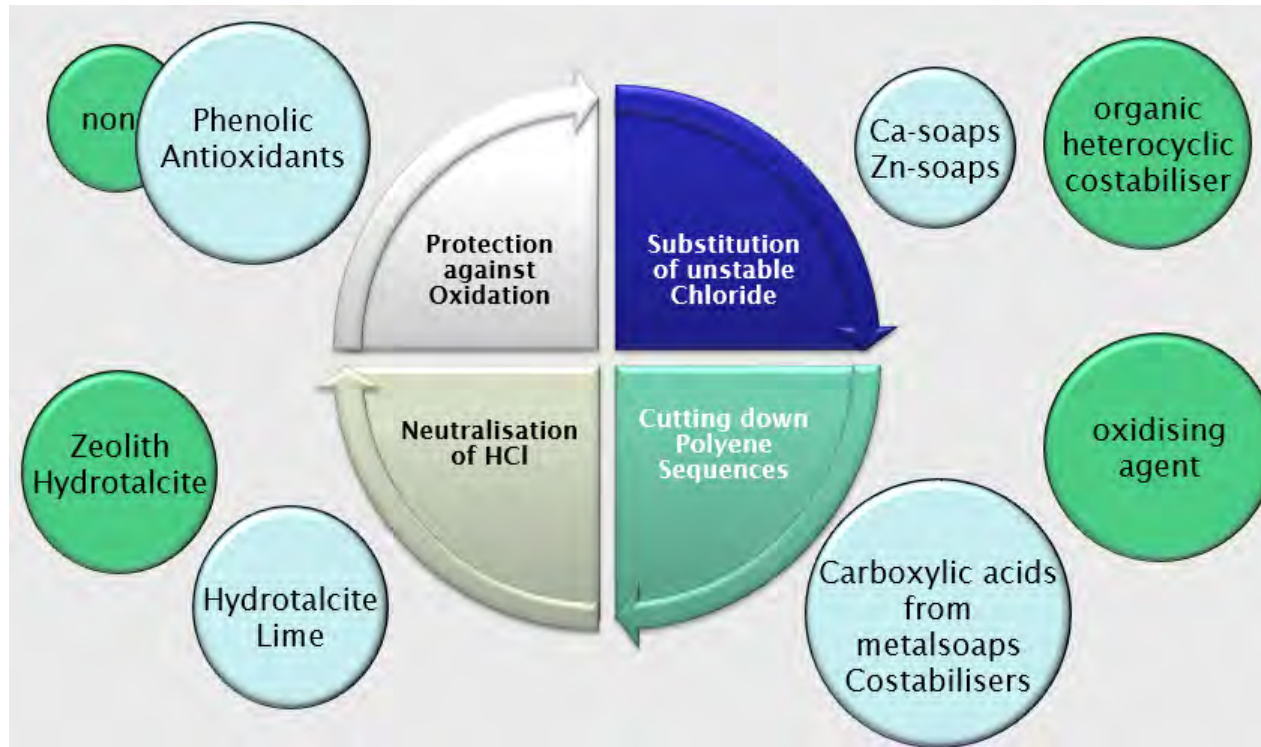




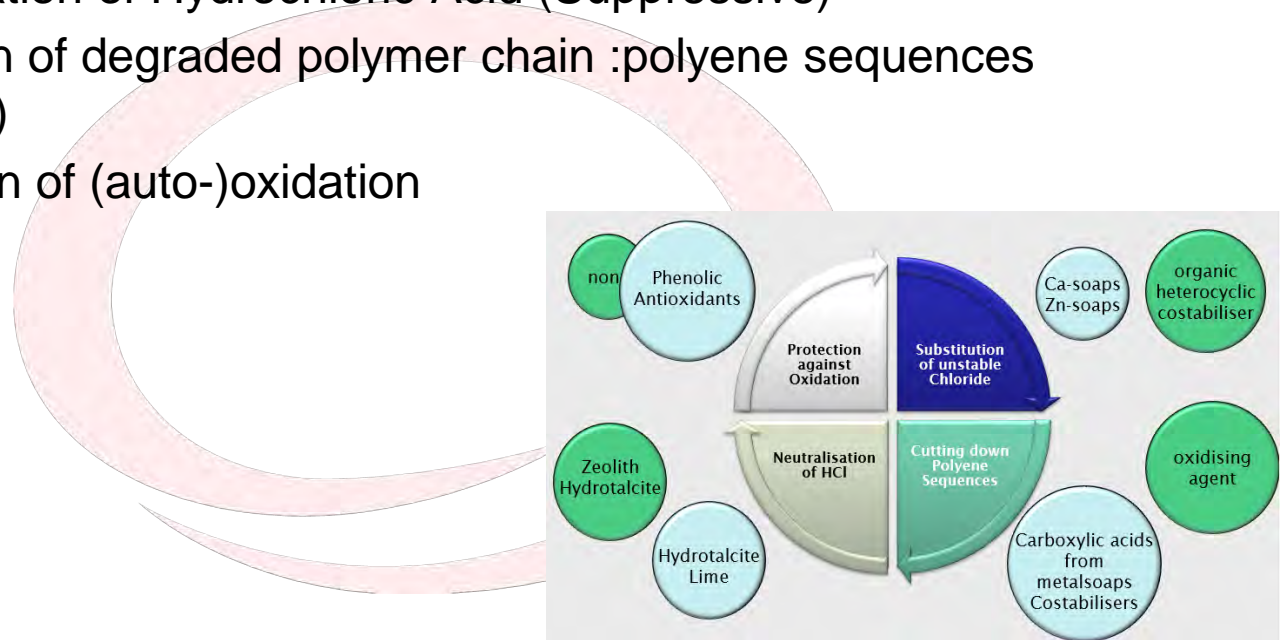




# PVC Stabiliser Systems -Demands



- > **Direct effect on PVC : enable processing**
  - > substitution of labile Chlorine (Preventative)
  - > neutralisation of Hydrochloric Acid (Suppressive)
  - > Reduction of degraded polymer chain :polyene sequences (Curative)
  - > prevention of (auto-)oxidation



## Ca/Zn

## Ca-organic

Substitution of unstable chloride

Zn soaps

Org. heterocyclic co stabiliser

Reducing polyene sequences (double bonds)

Carboxylic acids from metal soaps

oxidising agent

Co stabilisers :THEIC (Tris (2-hydroxyethyl) isocyanurate), Polyols, organo phosphites

Neutralising of HCl

Hydrotalcite, lime

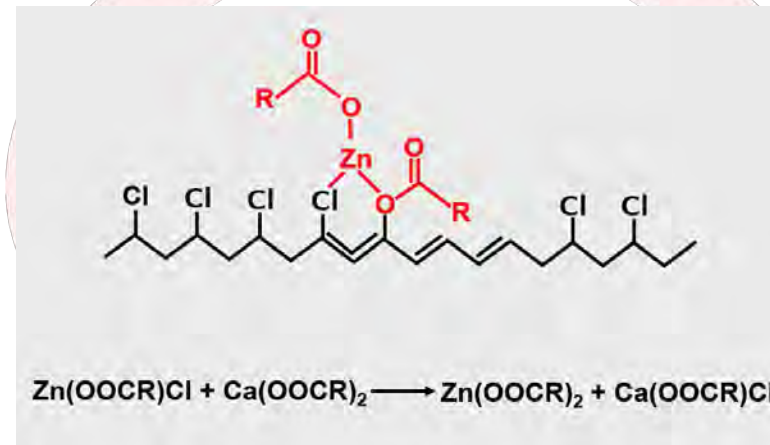
Zeolith, Hydrotalcite

Protection against oxidation

Phenolic antioxidants, HALS, UV stabiliser

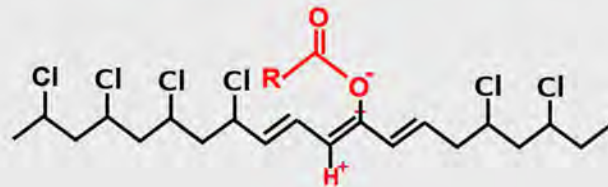
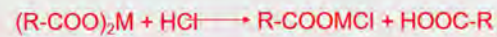


- > Zn soaps substitute labile chlorine and improve the colour
- > Due to the Lewis acid character heat stability is decreased
- > Compensate this with synergistic complexing agents (co stabilisers)



- > Ca-organic uracil substitutes labile chlorine in a similar way, without a negative effect on heat stability

- > Polyene sequences are responsible for yellow discolouration
- > The greater the sequence the darker the colour
- > Metal carboxylates attach themselves to a double bond
- > Initial colour and colour hold is improved

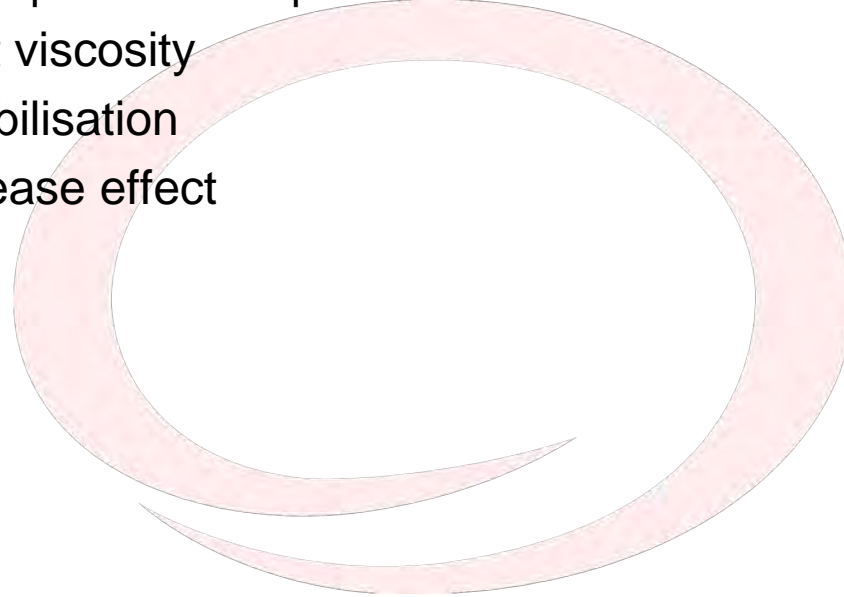


- > **PVC starts to dehydrochlorinate above 70°C**
- > **HCl, if left unchecked, will become autocatalytic in degradation: use acid scavengers to react or absorb HCl**
- > **Mostly metal soap and mineral agents used in both systems**
  - > Calcium stearate
  - > Hydrotalcite (Mg, Al hydroxycarbonate)
  - > Zeolite (Na-Al silicate)
  - > Brucite (magnesium hydroxide)
  - > Chalk (calcium carbonate)
  - > Lime (calcium hydroxide)

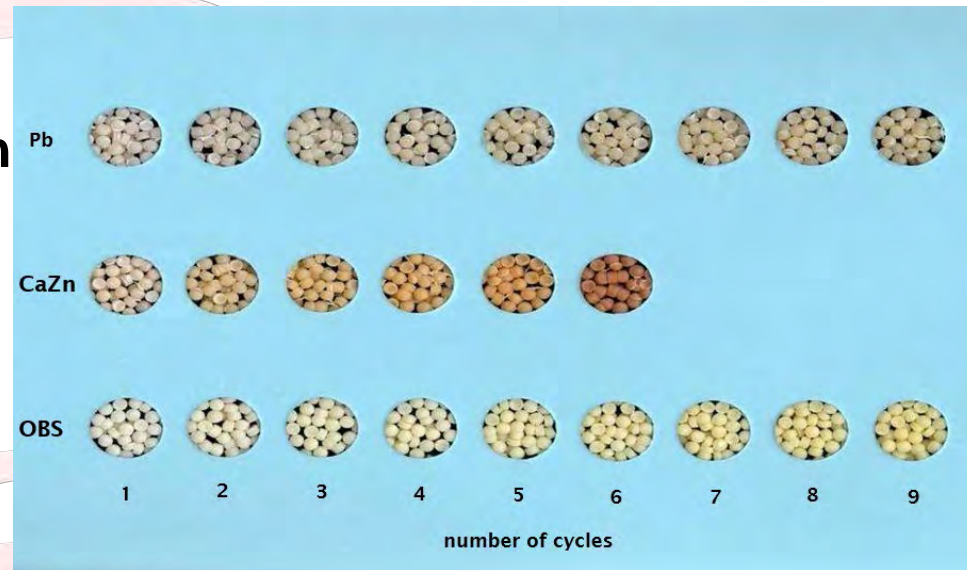
- > **Any polymer is subject to oxidation processes due to atmospheric oxygen. Increase in temperature increases the reaction.**
- > **Antioxidants are used in PVC to prevent autoxidation**
  - > Primary antioxidants are radicle scavengers, e.g phenols or amines
  - > Secondary antioxidants remove organic hydroperoxides formed by primary antioxidants e.g phosphites
  - > UV absorbers e.g benzophenones
  - > Light stabilisers e.g HALS

## > immediate effect on the process

- > point of gelation controlled by:
  - > Time, temperature and pressure
- > PVC melt viscosity
- > Compatabilisation
- > Metal release effect



- > Stabilisers also have a part to play after the extrusion process
- > Long term light stability
- > Long term physical strength
- > Ability to recycle



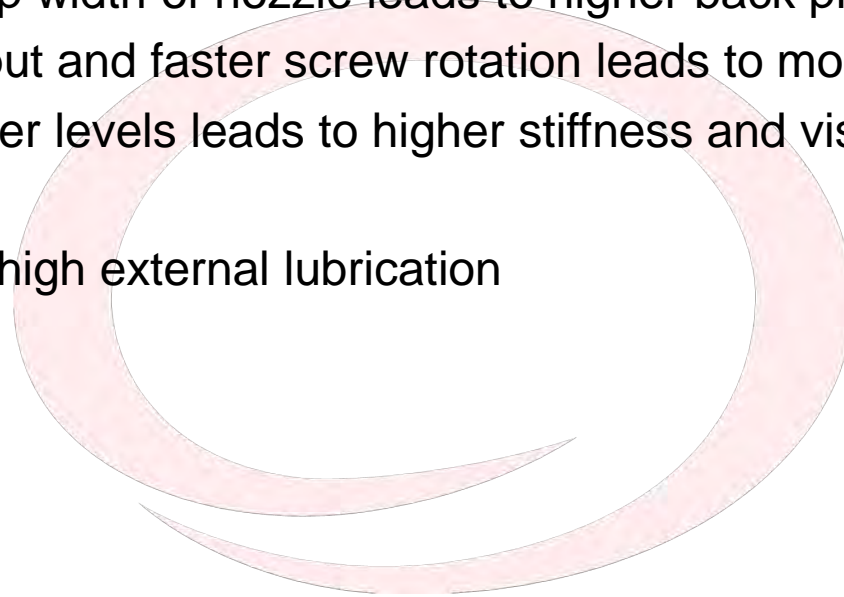
## > **Pressure pipe:** focus on *static thermo-stability*

- > Long residence time of material in the die head and down stream
- > Thick walled pipes cool slowly and have a relatively smaller inner surface area.
- > Less external lubrication required due to lower back pressure and higher demand on gelation- critical to withstand high pressure.



Ca-organic pipe 1200 x 23.6mm

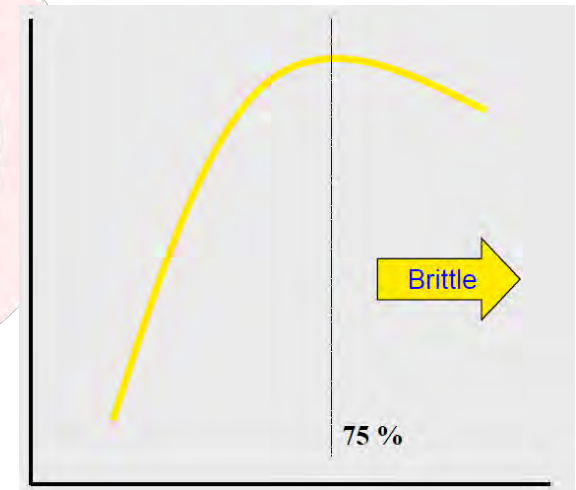
- > **Sewer & waste water pipes:** focus more on *dynamic stability*
  - > Lower gap width of nozzle leads to higher back pressure
  - > High output and faster screw rotation leads to more friction
  - > Higher filler levels leads to higher stiffness and viscosity
  - > Need for high external lubrication





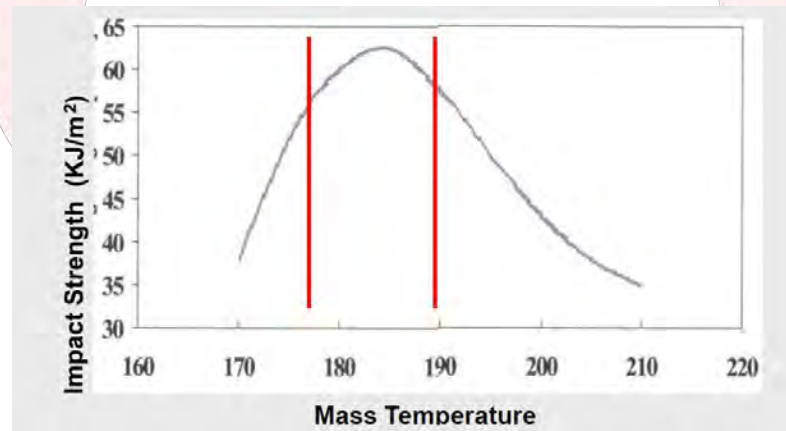
## Lubricants: important process control

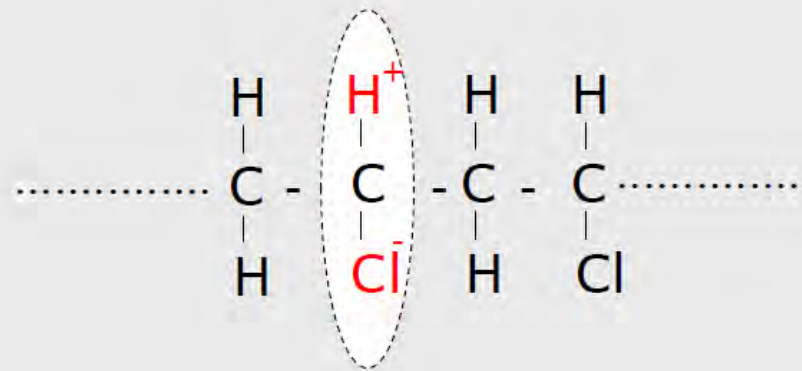
- > **Lubricants help to create a homogenous melt**
  - > Poor homogeneity – undispersed particles/ agglomerates > mechanical properties
- > **Lubricants help achieve the correct level of gelation**
  - > 75% gelation is optimum
    - > below this : poor physical performance
    - > Above this: reduction of physical performance
    - > Increase dehydrochlorination > colour



## > Over processing, not just a PVC issue:

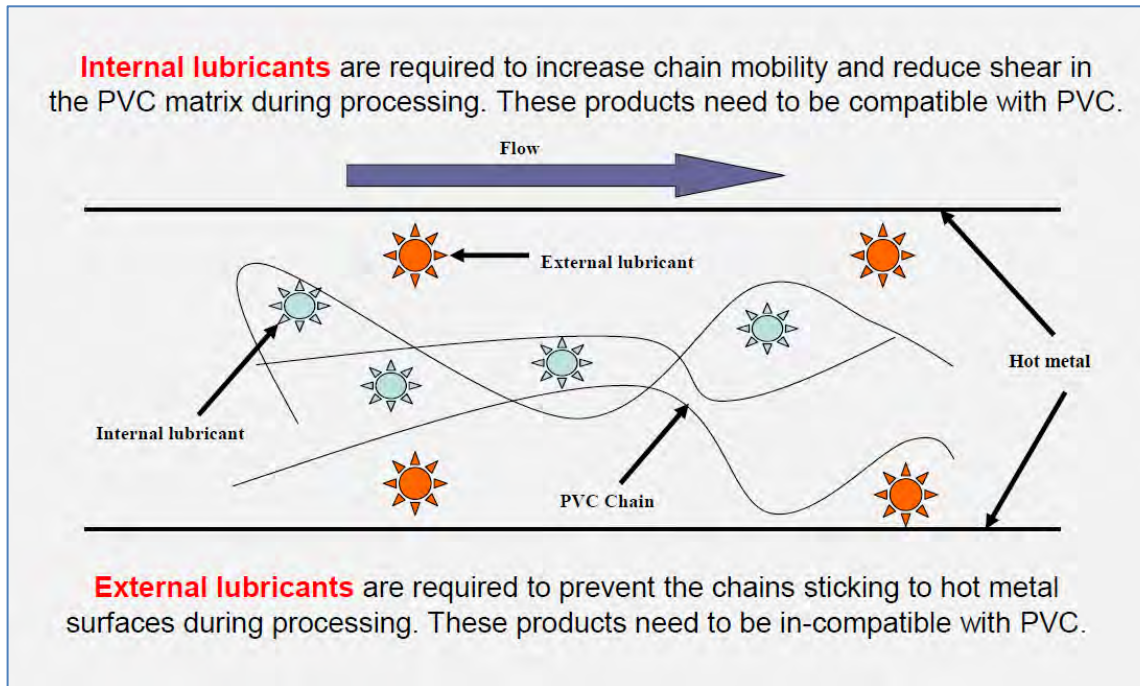
- > Impact modifier added to PVC to help overcome mechanical issues also has a processing window
- > CPE (chlorinated polyethylene) shown here has a narrow processing window. Excessive temperature leads to increase crystallinity
- > Crystallinity can develop over time as the pipe cools and impact strength, whilst initially was good, can deteriorate.





„DIPOL“ → PVC is a **polar** polymer

- > **Polar lubricants are compatible with PVC = Internal lubricants**
- > **None polar lubricants incompatible with PVC = External lubricants**



## Fischer Tropsch paraffin wax:

- > Most effective external lubricant
- > Positive influence on surface gloss
- > Delays gelation and decreases motor load

## > Polyethylene Wax:

- > Effective especially in the tool
- > Decreases back pressure
- > Good metal release

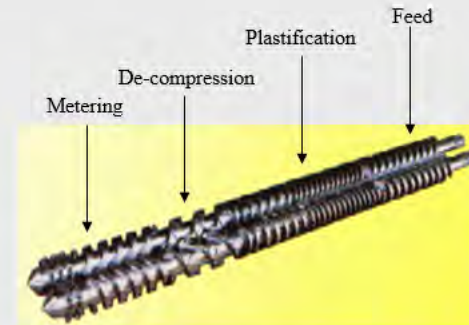
## > **Fatty Ester waxes:**

- > Decrease melt viscosity- especially for injection moulding and corrugated pipes
- > Decrease melt pressure, with no negative influence on gelation

## > **Oxidised Polyethylene waxes:**

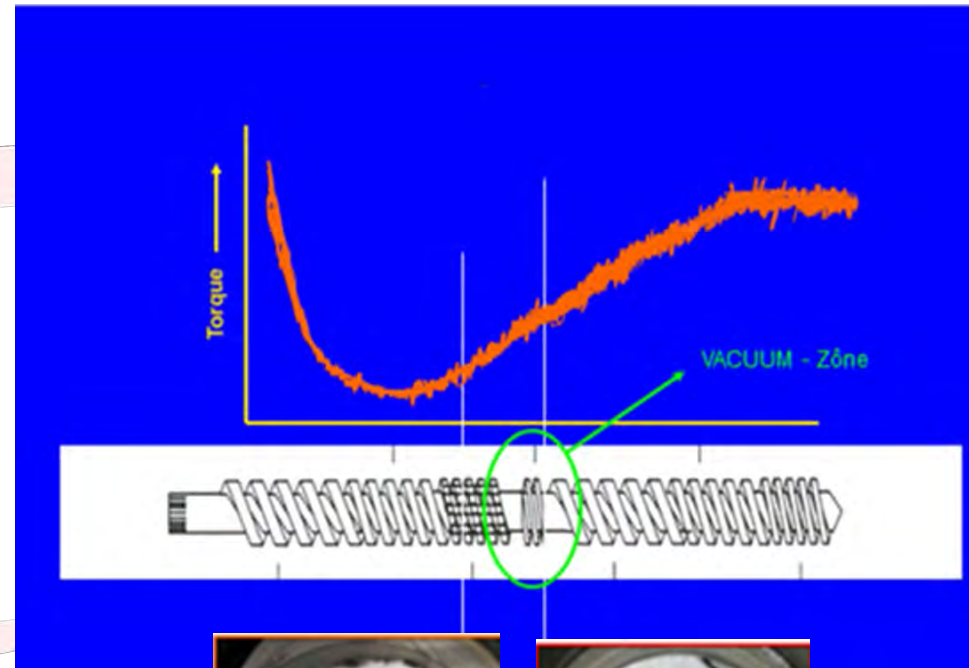
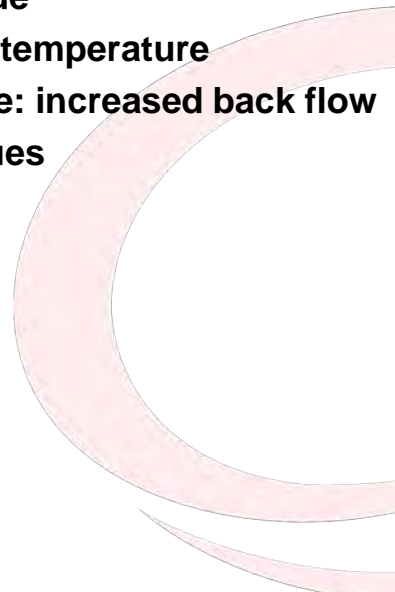
- > Very effective booster of gelation
- > High own viscosity
- > Negative influence on surface gloss

In the extruder, the PVC dry-blend is subject to heat from the barrels and shear from the screws. This causes the powder to melt (gel). Where on the barrel this occurs is controlled by the lubrication of the stabiliser one-pack. When the PVC reaches the adapter it should be a fully gelled homogeneous melt (180-190 degC).



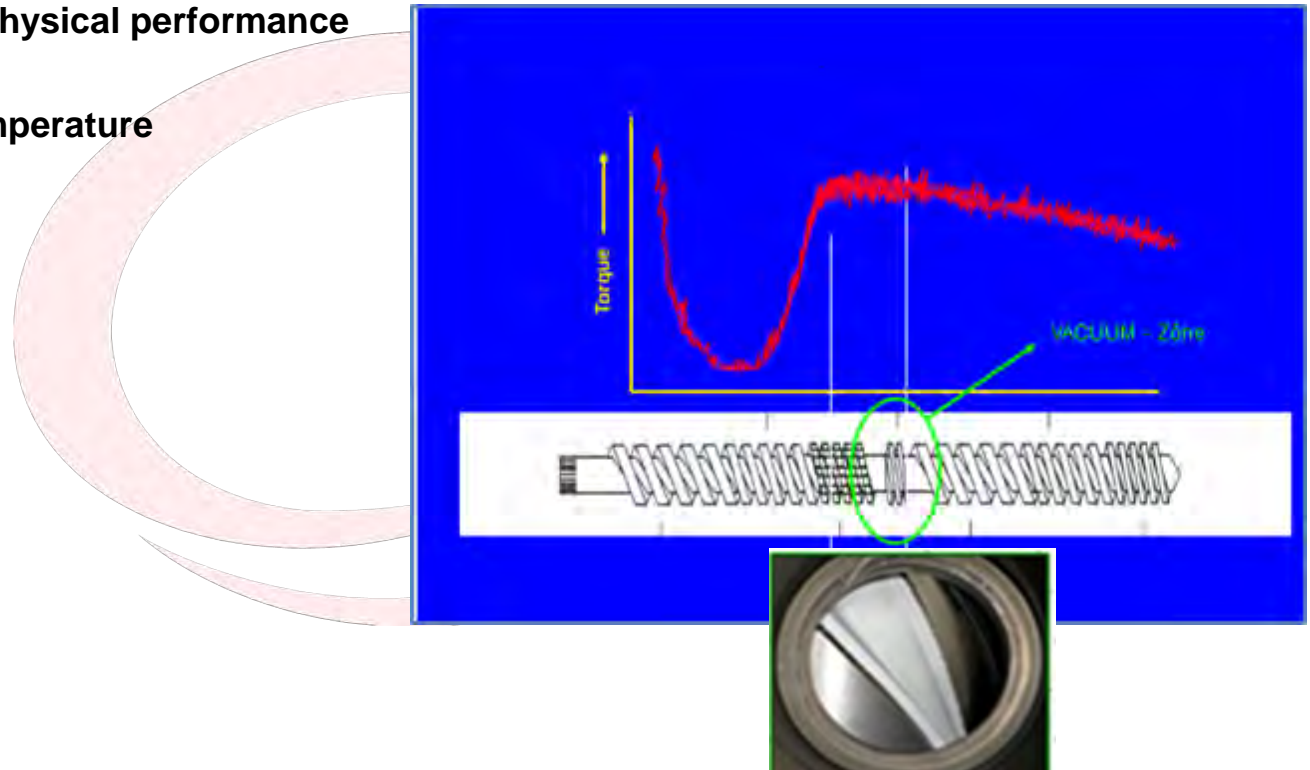
# Rheology : slow gelation issues

- > No de-venting of moisture or volatiles
- > Risk of powder blocking vacuum
- > Poor mechanical properties
- > Usually low torque
- > Usually low melt temperature
- > High die pressure: increased back flow
- > Dimensional issues
- > Lower output
- > Risk of burning

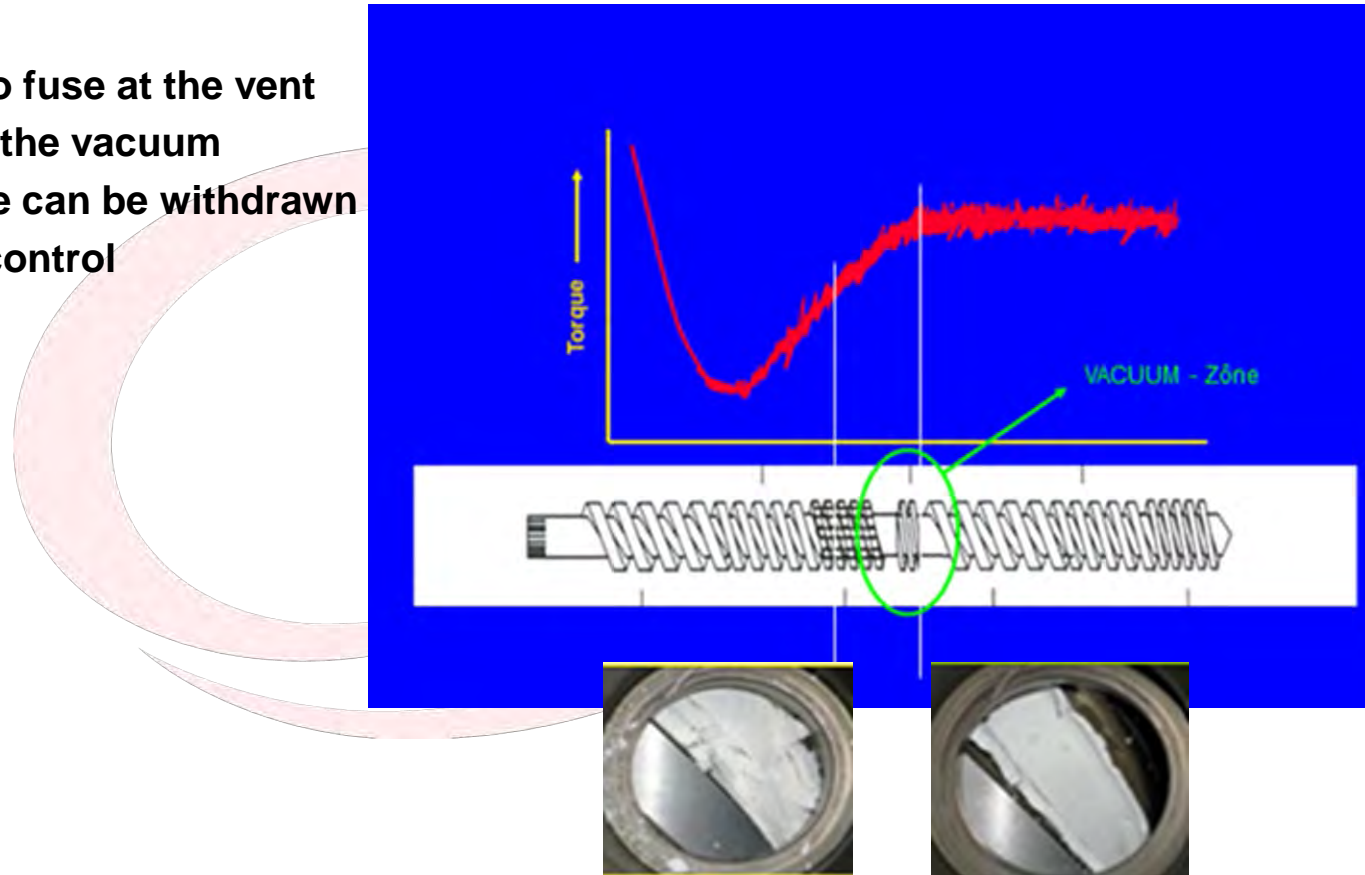




- > Poor de-venting (trapped moisture and volatiles)
- > Over gelation, poor physical performance
- > Usually high torque
- > Usually high melt temperature
- > Dimensional issues
- > Wavy inner surface
- > Possible burning
- > Discolouration
- > Risk of Plate out



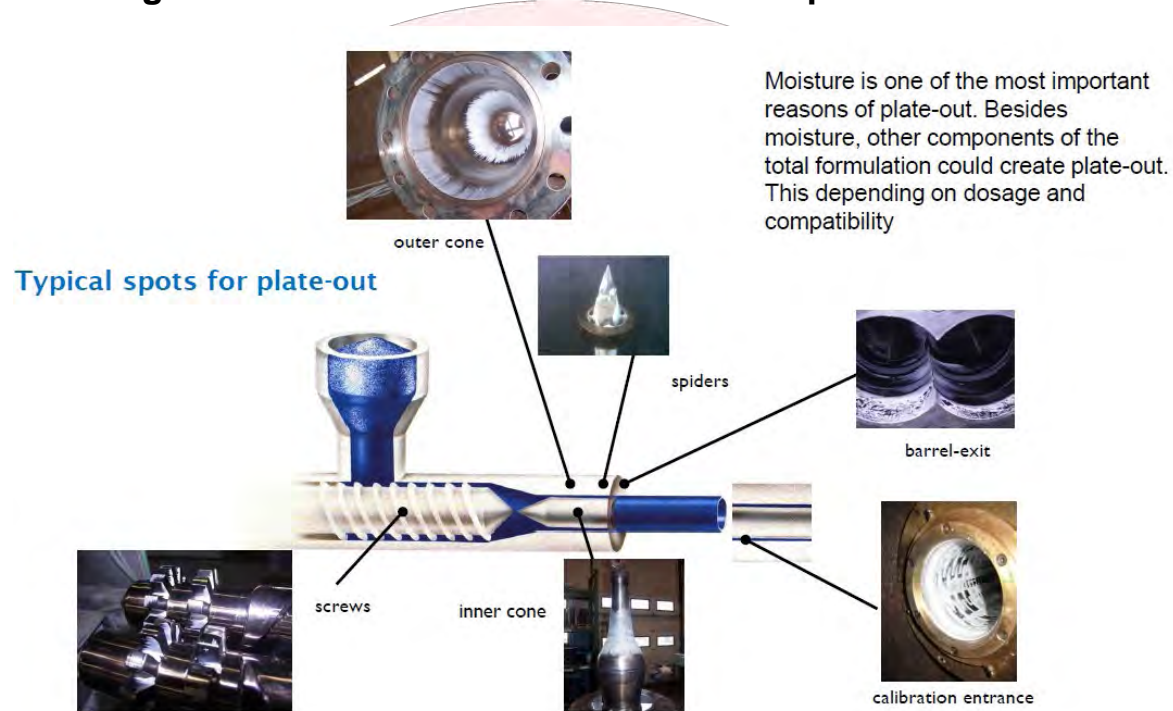
- > Material has started to fuse at the vent
- > Little risk of blocking the vacuum
- > Volatiles and moisture can be withdrawn
- > Processing is under control



**Moisture is always present in dry blend**

**Good aspiration is required in the mixing plant**

**Poor de-venting: moisture still in the melt can lead to plate-out**







Under gelation

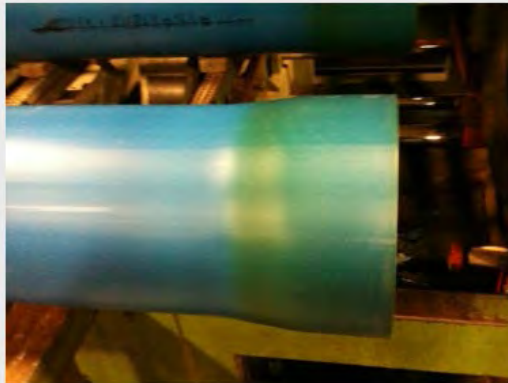


Over gelation



Die sticking

# Static and dynamic stability issues



Insufficient **static** stability  
More effective primary stabiliser



Burning due to **sticking to the screw**  
Different lubrication system



Insufficient **dynamic** stabiliser  
More effective primary stabiliser  
And lubricant system

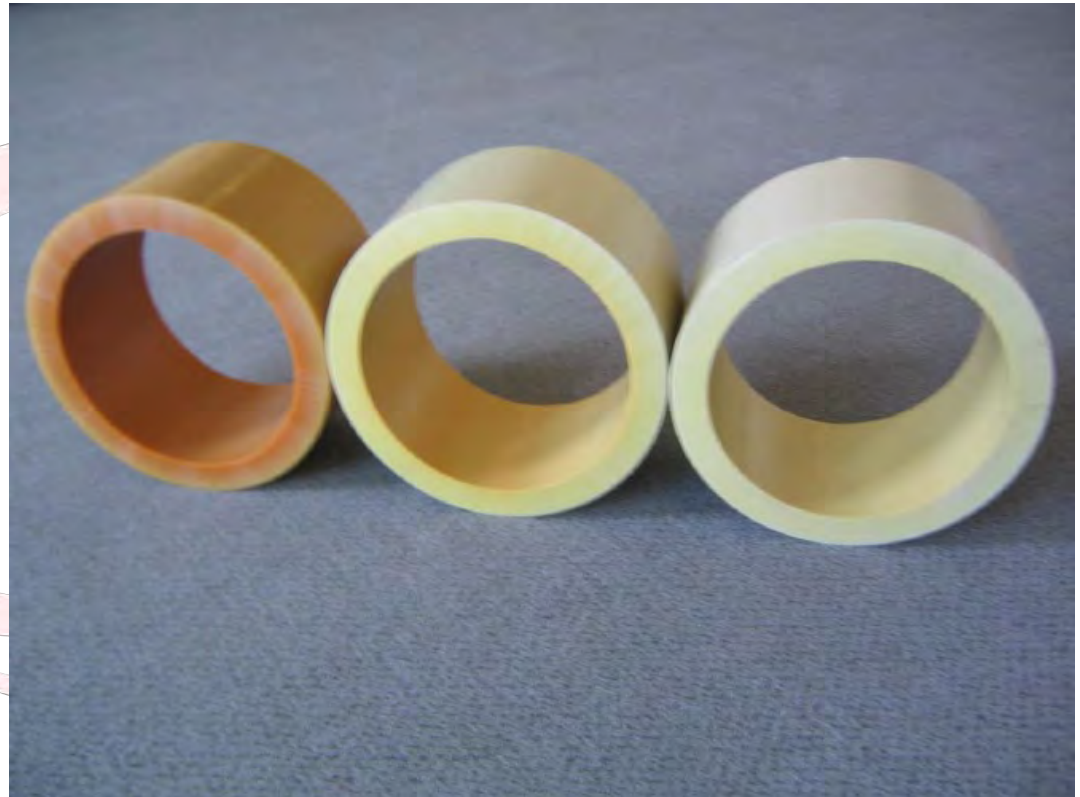
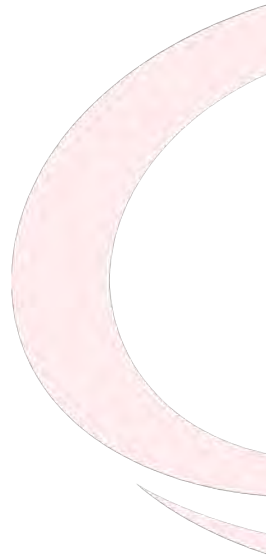


Insufficient **static- dynamic** stabiliser

Critical for thick walled applications  
And the use of different extruder types (friction)  
Increase **primary stabiliser and co stabiliser**



300mm rod





Discolouration due to  
Wrong choice of ingredients



Discolouration due to degradation



Discolouration due to "chalking"  
Change lubricant system, add UV resistance  
improve pigments



- > **PVC's dipolar nature gives it the ability to be combined with a wide range of ingredients to alter the end application from flexible film to rigid pipe**
- > **Achieving the correct level of gelation is critical to PVC performance**
- > **Stabiliser one packs allow processors to achieve this**
- > **Correct balance of ingredients can help open up a broader processing window, even on challenging products**

# *Akdeniz Chemson*

# Questions and Answers



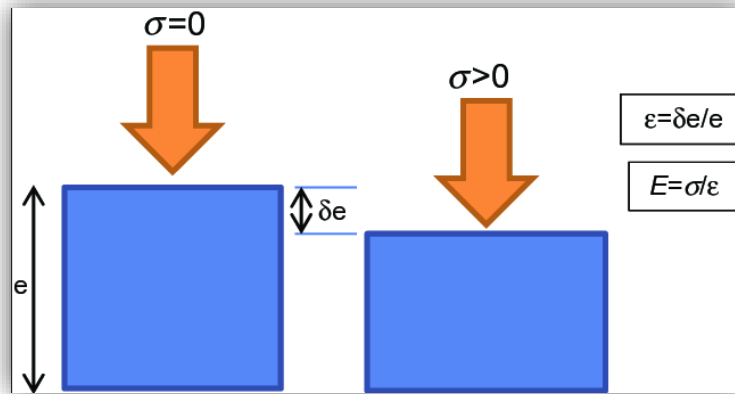
 **Akdeniz Chemson**  
Beyond Additives

**Chris  
Cheeseman**



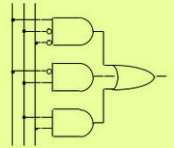
# Remember it all needs to add up

The product is the sum of all its components

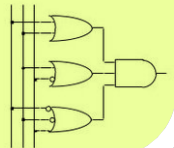


## Implementations of Two-level Logic

- Sum-of-products
  - AND gates to form product terms (minterms)
  - OR gate to form sum



- Product-of-sums
  - OR gates to form sum terms (maxterms)
  - AND gates to form product



Your Strength is a function of your Stress and Strain

*Allow us to look into your Stresses and Strains*



Synergies come from joining strengths we often do not think of



# SAPPMA Webinar IX

*Thank You*

*Participants  
Audience  
& Organizers*



# Questions and Answers



[ian@sappma.co.za](mailto:ian@sappma.co.za)  
admin@sappma.co.za

