Effects of Imputities on Suspension PVC Resin Quality

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Abstract: In suspension polymerization techniques, it has been visualized that there are direct relations between system impurity levels and Poly Vinyl Chloride (PVC) resin quality. Such impurities are originated from two main sources, the first one is derived from Vinyl Chloride Monomer (VCM) whereas the second one is related to process water quality. This study has revealed that vinyl Chloride Monomer impurities have a great impact on PVC resin quality. On the other hand impurities related to process water have adverse effects on PVC resin particle size and enhance the frequency of coarse charges.
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Introduction

In the suspension process used for the manufacture of PVC resin, liquid vinyl is dispersed in water, as 5-150 micron droplets with a mean size of around 49 microns, by a suitably designed agitation system.

Protective colloids are used to prevent dispersed droplets from Coalescence. This will also control agglomeration of the partially polymerized droplets during polymerization.

Polymer Characteristics

Many parameters affect the PVC polymerization process and all need to be considered in order to produce product which satisfies market application requirements.

The most important which characterize a PVC resin are:

- MELT VISCOSITY.
- PARTICLE SIZE DISTRIBUTION.
- PARTICLE MORPHOLOGY (POROSITY).

Vinyl Chloride Monomer and process water qualities play an important role to control PVC particle properties.

In this study, we have considered the impact of impurities derived from both Vinyl Chloride Monomer and process water as main feed stocks in suspension polymerization.

Impact of VCM impurities on PVC resin quality.

VCM impurities are either derived from VCM monomer production facilities or from recycled monomer in the Poly Vinyl Chloride production units.

The first source is manly due to inefficient VCM purification, especially Acetylene, Butene-1, cis-Butene methyl chloride, acetylene, chloroprene, 1-1-EDC, 1-1-1-TEC, CCl_4, TCE, Whereas the second source is due to the recycled VCM from reactors and recovery system of PVC production, such as HCI, oxygen, Acetylene, Butene-1 Cis Butene and menthyl chloride.

From actual charge report analyses, it has been clarified that such VCM resin quality, productivity and equipment:

1. Poor yellowness Index in PVC resins.
2. Unpredictable resin particle size control and the deviation of other properties.
3. The contribution to coarse charges.
4. Increased scale-type buildup in the polymerizers.
5. Reduced resin heat stability.
6. Variable emulsifier effect in Suspension resins.
7. Accelerated corrosion in recycle equipment.
8. Consumption is limited to non-film grade Suspension resin.
9. Productivity is reduced, especially in product changeovers, to control RVCM quantities.
10. Limited consumption/storage frequently creates problems with environmental equipment.
11. Monomer efficiency is affected due to no adjustments being made for RVCM impurities.
12. Variability of RVCM properties results in numerous recipe adjustments, not able to consume at a fixed % RVCM per charge.
13. Testing costs are increased due to analysis of test charges for % RVCM recipe adjustments.
14. Generation of off-specification resin due to RVCM adjustments.

In addition the individual impacts of major impurities on PVC resin quality have been evaluated as follows:

A. An increase in the level of Butene-1 in the recycle monomer will:

a. increase porosity.

b. decrease average particle size.

c. increase % passing through the 140 mesh screen.

B. an increase in the level of oxygen in the recycle monmer will:

a. increase porosity.

b. decrease average particle size.

c. decrease the particle size distribution.

C. an increase in the level of HCI in the recycle monomer will:

a. decrease porosity.

b. decrease the average particle size.

c. increase the % passing through the 140 mesh screen.

Impact of Water Quality on PVC Resin

Water used in the suspension process performs several roles. It enables the heat of polymerization from the polymerizing VCM droplets to be transferred to the reactor walls and reduced the viscosity of the PVC slurry.

The other extremely important role of the water, however is to carry the protective colloids, most of which are water soluble, which largely determine the morphology of the PVC granule. The properties of these materials and the effects they produce on the PVC granule are markedly affected by the presence if ionic salts in the water such as Fe^{++}, So = 4, Ns^{+}, cl^{-}, Sio_2 total hardness, PH,…etc.

Therefore, water purity is an important feature of the suspension process.

An information package system is utilized to evaluate water quality needs, such a package contains the following items:

1. Water quality.
2. Demineralized water specification.
3. Recommended prodcedure and solution recipes for periodic rinses to improve ion exchange resin bed performance.
4. Dramatic effects of soluble silica and sulfates on PVA.
5. The relation between silica breakthrough occurrence and the conductivity increase.
6. The effect of sodium levels on the cloud point temp. (C) of PVA 72.5 solution.
7. The effect of PH on the cloud point intensity of PVA solution.

Since uniformity abd reprodycibility are very important factors of water quality in polyvinyl suspension processes it has been proven that Polymerization recipe adjustments can be made to overcome adverse effects of water impurities if consistencey is attained but with widely varying impurity levels, unfavorable results are very likely to occur.

Interpretation of Results

1. It can be definitely said that Butene-1, level in recycle monomer has a great effect on PVC resin quality.

How ever any effect attributeted to Butene-1 could be the result of either Acetylene, Methyl Acetylene, or Methyl Chloride.

Likewise, changes in oxygen level were closely associated with changes in HCI level were associated with changes in propylene, Butene-1, and Methyle Acrtylene.

2. The results obtained clarify that all recycle charges with high impurity levels give a lower porosity and finer particle size when compared to "mixed" charge of fresh and recycle monomer.

The mixed charge results are in the same relationship when compared to all fresh changes except the effect of high oxygen levels upon porosity.

3. Also, it has been found that high PH resulted in high PH "de-activating" the peroxide catalyst.

The "tie-up" of the HCI with Tricalcium Phoshate as a buffer has been successfully applied.

4. The concentration of irons has an adverse effect on PVC resin particle size, whereas the variations in PH value will enhance the frequency of coarse charges.

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