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Raw Material Specifications for Plastics Parts Implementing ISO 14000

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Abstract: Over the last few decades major efforts to reduce manufacturing costs have focused on direct labor. Major improvements in automation and information technology have reduced raw material costs significantly. Therefore raw material costs have emerged as the most significant cost for manufactured goods. Raw material costs are increasing due to global demand. It is important for students to become knowledgeable about the numerous ways to reduce material costs and how this should be specified in a product drawing. Students should be encouraged to consider the use of recycled materials and the implications of raw material cost on the overall product cost during the design stage.

Key Words: ISO 14000, specifications, recycling, unit cost, raw material cost
Grade Level Intended: Tech High School Seniors and College Freshman
Mode of Presentation: Classroom or Computer Aided Design lab demonstration
Prerequisite Knowledge: algebra, trigonometry and some blue print reading
Equipment and Supplies Needed: None

Objectives: This demonstration has two objectives. The first is to instill in students that the product drawing (blueprints) plays a central role in implementing ISO 14000 and to a great extent establishes unit cost. The second objective is to encourage students to carefully reflect on the types and grades of materials they specify and determine whether recycled materials are appropriate for a given application. This demonstration focuses on specification of raw materials for plastics components and explores what considerations need to be made before considering recycled materials.

Student Learning Objectives:

After studying this material the student will be able to:

list the various ways to determine part volume.
research plastic raw material cost.
calculate cost per part given the part volume and cost per unit volume.
calculate the percentage of retained value for recycled materials vs. new raw material.
explain the fundamental difference between new raw material and recycled raw materials.
research and discuss the mechanical property implication of using increasing percentages of regrind.
suggest what aspect of the design limits the life cycle of the product.
explain the economic implication for a given industry if aggressive vs. poor recycling practices prevail on the overall cost of raw materials.
explain how crude oil prices effect plastic resin prices.

Procedure

Pre- class exercise and possible homework assignment
The faculty should ask their students to review a simple product drawing and consider (guess-estimate) what percentage of a plastic component cost is made up of labor, raw materials, and processing. They should be pointed to the following web site: www.plasticstechnology.com. This website has the latest information on raw material cost new resin as well as recycled resins. They should be asked to take a simple product and determine its raw material cost. This can be done by simply weighing the part. Volumetric data from a CAD 3D solid model would be helpful but not necessary. This information is usually found in the mass properties table for most CAD software.

Classroom or CAD Lab Discussion

Discussion and demonstration – I Pod protective case- CAD drawing and component. We are fortunate that we have the solid model CAD drawing and related information. From the mass properties chart we can select the part volume in any units that are convenient. With this information we can simply calculate the raw material cost per unit as:

Raw material cost per part = part volume X part cost per unit volume

This is pretty straight forward. Regardless, how does this calculation change as increased percentages of lower cost recycled material are used? These exercise also provides a good opportunity to review unit conversions.

Student need to understand what should be listed on a product drawing for the Raw Materials Specification. Therefore, the product drawing must list;

- *Type, grade, and manufacturer of raw material*
- *Alternative grades and manufacturers. Why?*
- *The maximum percentage of regrind material is acceptable. But how do you know how much?*

How do we determine what that maximum percentage is acceptable?

If there is doubt about what percentage of recycled material to use in a given application than life cycle and field testing must be conducted. The "gold standard" for plastic raw material testing is by measuring the molecular weight distribution using a gel permeation chromatography unit (GPC). This instrument is actually a "molecular sieve" which separates plastic molecules by size and amount. These distribution shift as plastics raw materials see successive heat histories. You might want to ask students how the distribution will shift with successive heat histories and why. The GPC can be used to "fingerprint" a material and help establish an acceptable distribution for a given product based on its function and its intended service life. Another tool is the extrusion plastometer which measure melt viscosity in grams per ten minutes. The best mechanical property test is either life cycle or impact type test to determine product durability.

Conclusion:

This exercise is intended to enable educators to help students gain knowledge about how increasingly raw material cost are playing an increasingly important role in overall product cost. It also helps them understand the value of recycle materials and the need for to maximize recycling to reduce or at least stabilize raw material cost.

Evaluation:

Provide students with a simple product drawing and ask them to calculate volume by hand and then calculate raw material cost. Various percentages of regrind can be added to determine the effect on final cost of raw materials.