ITCD 301-001 Tool and equipment design: Fall 2010

Homework # 2, **Due date - October 1, 2010, before 11.55 PM EST**

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1. What are continuous chips with built up edge? What are the conditions that aid in the formation of these chips? (5 points)

Consideration of chip flow along the face of the tool, in the formation of continuous chips, is of prime importance. If the friction force resisting the passage of the chip along the tool face is less than the force necessary to shear the chip material, the entire chip will pass off cleanly. Often, a built up edge will not appear at very low cutting speeds, then start to appear as the cutting speed is increases, peaking and starting to decrease as the cutting speed is further decrease as the cutting speed is further increased. Higher cutting speeds are favorable if there are no adverse effects. The built up edge is common to most metal cutting operations and particularly evident in machining aluminum and some stainless steels. The edge builds up to a point where it eventually breaks down, part of it going off with the chip, and part of it being deposited on the work surface. This characteristic occurs at rapid intervals.

2. What are the ‘manipulating factors’ in chip formation? Explain each one of them. (5 points)

* Velocity: the speed at which the cutting edge moves through the workpiece material. It affects temperature which in turn affects the cutting process. At low velocities, the temp. at the tool point is below the recrystallization temp. of the material. As a result, work hardening in the chip is retained and the workpiece material is not softened due to failure to reach the yield strength temp. of the material.
* Size of Cut: changes in the size of cut effectively change the cross sectional area of chip contact. An increase in depth of cut for constant feed merely lengthens the contact but doesn’t change the thickness, so force per unit remains the same. An increase in feed for a given depth widens the area of contact and changes the force per unit length. This results in greater chip distortion and reduced tool life, although increased feed reduces machining cycle.
* Tool Geometry: has two direct effects on chip formation, effect upon shear angle and effect on chip thickness.
* Tool Material: ability to sustain high cutting velocities and the coefficient of friction between the chip and tool material
* Cutting Fluids: provides lubrication between chip and the tool. Constant, even flow is essential when cutting fluids are applied with carbide tools to prevent thermal shocking and resultant flame.
* Workpiece Materials: brittle materials form discontinuous chips and can be machined with a neutral rake. Cutting forces are usually lower and tool life is longer than for a ductile material of corresponding strength because of generally large shear angles and lower resistance along the tool face. Ductile materials produce continuous chips.

3. Using the Taylor equation for tool wear and letting n = 0.4, calculate the % increase in tool life if the cutting speed is reduced by (a) 20% and (b) 50%. (15 points)

4. Estimate the machining time required in rough turning a 1.25 m long, annealed aluminum alloy round bar that is 75 mm in diameter, using (a) High speed steel tool at a maximum cutting speed of 4 m/s, and (b) carbide tool at a maximum cutting speed of 7 m/s. Both cases use a feed of 2 mm/rev. (15 points)

5. How does the side cutting edge angle and nose radius affect the tangential, longitudinal and radial tool forces involved in a cutting operation? (5 points)

* Side Cutting Edge Angle: between the straight cutting edge on the side of the tool and the side of the tool shank. It provides the major cutting action and should be kept as sharp as possible.
* Nose Radius: connects the side and end cutting edges and dramatically effects tool life, radial force, and surface finish. Sharp pointed tools have a radius of zero. Increasing the nose radius from zero avoids high heat concentration at a sharp point.

6. Explain the mechanism of tool wear. (5 points)

There are 5 basic causes of wear:

* Abrasion action of hard particles contained in the work material
* Plastic deformation of the cutting edge
* Chemical decomposition of the cutting tool contact surfaces
* Diffusion between work and tool material
* Welding of asperities between work and tool

7. A 200 mm long, 75 mm diameter 304 titanium alloy rod is being reduced in diameter to 65 mm by turning on a lathe. The spindle rotates at 400 rpm, and the tool is traveling at an axial speed of 250 mm/min. Calculate the cutting speed, material removal rate and cutting time. (15 points)

8. If the cutting conditions in a turning operation are cutting speed = 300 ft/min, feed = 0.010 inch/rev, and depth of cut = 0.100 inch, which one of the following in the material removal rate (MRR): (a) 0.025 in3/min, (b) 0.3 in3/min, (c) 3.0 in3/min, or (d) = 3.6 in3/min. Support your answer with calculations. (15 points)

Answer is D.

9. Tool life tests in turning yielded the following data. (1) When cutting speed is 100 m/min, tool life is 10 min; (2) when cutting speed is 75 m/min, tool life is 30 min. Determine the following. (a) Find n and C values in the Taylor tool life equation, (b) based on the equation compute the tool life for a speed of 110 m/min, and (c) compute the speed corresponding to a tool life of 15 min. (15 points)

10. What are chip breakers? Explain why and where it is used.(5 points)

An irregularity or channel cut into the face of a lathe tool behind the cutting edge to cause removed stock to break into small chips or curls.

<http://www.answers.com/topic/chip-breaker>