Unit 5 - Week 3

Course outline

Assignment 3

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-02-19, 23:59 IST.

Unless otherwise stated, assume

$$MRR = \frac{\dot{M}_{abr} \times V^{1.5}}{\rho^{0.25} \times H_w^{0.75}}$$

And

$$MRR = V_g \times d_g \times w_g$$

And

Mixing ratio in AJM is the ratio of mass flow rate of abrasives to that of the carrier gas. As per experimental data, when mixing ratio is kept constant, MRR in AJM of brittle work material is found to be directly proportional to the mass flow rate of abrasive grits

1) *1 point*

An AJM set up is being used to cut grooves in one pass of depth 0.2 mm at a speed of 150 mm/min in a glass part. The abrasive particles used are SiC (case 1) with hardness of 25.5 GPa and density 3.15 g/cc. Now (case 2), the abrasive is changed to Al_2O_3 (hardness 22 GPa and density 3.95 g/cc). Mass flow rate of abrasives and gas jet velocity remain same as before. Assume, for both cases,

$$MRR = V_g \times d_g \times w_g$$

Where V_g = grooving speed , d_g = groove depth and w_g = groove width. Also assume that groove width w_g is not affected by change in parameters. The grooving speed V_g (m/s) to be employed to cut the same glass part in one pass in case 2, is nearest to

a. 20.8×10^{-4}
b. 23.6×10^{-4}
c. 26.3×10^{-4}
d. Near to none of these by $\pm 0.5 \times 10^{-4}$

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

2) *1 point*

In an AJM set-up, a student is assigned the task of finding out how energy efficient the process of AJM is for Material removal from a glass work piece. Assume that power input is $\frac{1}{2} \times (\dot{m}_g + \dot{m}_{ab}) \times V^2$. For his analysis, he uses the specific energy of material removal in AJM (Energy required for removal of unit volume of material) for glass. This has the form

a. $k \times \frac{m.r.}{(1+m.r.) \times H^{0.75}}$

b. $\frac{k}{(\rho \times V^2)^{0.25}} \times \frac{m.r.}{(1+m.r.) \times H^{0.75}}$

c. $k \times \frac{(\rho \times V^2)^{0.25}}{(1+m.r.) \times H^{0.75}}$

d. None of these

Where k = constant

m.r. = Mixing ratio

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
d.

3) *1 point*

Two abrasive types A_1 and A_2 are used in two cases of AJM, where parameters $\dot{M}_{abr}$, V, H_w and average size of abrasive particles are same but density of the two abrasives ρ_1 and ρ_2 are different ($\rho_1 > \rho_2$) respectively. It is found that $MRR_1 < MRR_2$, as per formula of MRR.

$$MRR = \frac{\dot{M}_{abr} \times V^{1.5}}{\rho^{0.25} \times H_w^{0.75}}$$

A student is puzzled that heavier abrasives, carrying more energy, are causing lower MRR. The physical explanation is

a. Volumetric MRR is calculated, not weight MRR
b. $\dot{M}_{abr}$ cannot be the same in two cases where V is same but density of abrasives are different, so the same equation cannot be applied
c. The number of indenting particles will be higher in case of abrasives with lower density if $\dot{M}_{abr}$ is same in the two cases, hence $MRR_1 < MRR_2$
d. None of the others

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

4) *1 point*

In an AJM factory, a worker is doing a grooving operation on parts and achieving a target value of grooving 80 such parts in 8 hours. However, demand of that part increases in the market and factory plans to produce 100 such parts in 8 hours. In that case, the target can simply be achieved by

a. Keeping all parameters same, simply increasing the grooving velocity by 25 %
b. Increasing the mass flow rate of abrasives while maintaining same mixing ratio and maintaining same grooving velocity as before
c. Increasing both grooving velocity and mass flow rate of abrasives by 25% while keeping the mixing ratio to be constant.
d. None of these

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

5) *1 point*

The range of speed of abrasive-gas jet in case of AJM is closest to (in m/s)

a. $1 - 10$
b. $10 - 50$
c. $150 - 300$
d. None of these

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

6) *1 point*

The main material removal mechanism in AJM of brittle materials is by

a. Electrical discharge machining
b. Impact erosion
c. Thermal ablation
d. None of these

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

7) *1 point*

The main advantage of AJM over competing methods is that

a. AJM is capable of very high material removal rates
b. The AJM set-up is inexpensive and simple
c. Width of grooves is in the range of 20 – 50 nanometres
d. None of these

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
b.

8) *1 point*

In case of AJM,
Let M_1=Mass of one hemispherical shaped material piece removed from work piece surface due to the impact of one hard rigid spherical abrasive particle of mass $2m$, velocity V, density ρ striking a flat, hard and brittle work piece of hardness H.
And M_2 = Sum of the masses of 2 hemispherical shaped material pieces removed from work piece surface due to the impacts of two hard rigid spherical abrasive particles, each of mass m, velocity V, density ρ striking a flat, hard and brittle work piece of hardness H.
The material of the abrasives in both cases is the same. The work piece material in both the cases is the same.
In that case, as per theory of material removal from brittle materials in AJM,

a. $M_1 = M_2$
b. $M_1 > M_2$
c. $M_1 < M_2$
d. There is no definite relation between M1 and M2

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
a.

9) *1 point*

In Abrasive jet machining, the size of abrasive particles is in the range of

a. 1-2 nanometers
b. 2-3 mm
c. 10 – 50 microns
d. None of these

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.

10) *1 point*

. An abrasive jet machine (AJM) can cut a groove of depth d = 2 mm in soda lime glass at the grooving speed V_g = 20 mm/min. Assume groove width w_g to remain constant and take $V_g \times d_g \times w_g$ = MRR. MRR is given by

$$MRR = 1.04 \times \frac{\dot{M}}{\rho^{0.25}} \times \frac{V^{1.5}}{H^{0.75}} \quad ...(1)$$

Where $\dot{M}$ = abrasive mass flow rate in kg/s, ρ = density of abrasive material, kg/m³, V = Velocity of abrasive-gas jet in m/s, H = hardness of work material in N/m²

If the ratio of hardness of soda lime glass to that of Borosilicate glass is 0.86, the grooving speed attainable by AJM machine in Borosilicate glass for the same groove depth is nearest to

a. 18.9 mm/min
b. 16.1 mm/min
c. 17.8 mm/min
d. Near to none of these by ±0.5 mm/min

- a.
- b.
- c.
- d.

No, the answer is incorrect.
Score: 0
Accepted Answers:
c.