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# Swirling Abrasive Fluidized Bed Machining: Effect of Process Parameters on Machining Performance

N. K. Francis[1], K. G. Viswanadhan[2], and M. M. Paulose[3]

[1]*Department of Mechanical Engineering, Karpagam University, Coimbatore, Tamil Nadu, India*
[2]*Department of Mechanical Engineering, NSS Engineering College, Palakkad, Kerala, India*
[3]*Department of Mechanical Engineering, MBITS, Kothamangalam, Ernakulam, Kerala, India*

Swirling Abrasive Fluidized Bed Machining (SA-FBM) is a novel variant of Fluidized Bed Machining (FBM). This research focuses on the experiments performed on copper specimens using silicon carbide abrasive particles to investigate the influence of operating parameters such as grain size, superficial velocity, and machining time on metal removal rate, transformation of surface texture, and the surface finish. The study concludes that the surface modification is faster with SA-FBM compared with conventional FBM; the initial roughness conditions of the workpiece have no effect on the maximum possible surface finish; moreover, for faster metal removal, higher superficial velocity, and for better surface finish, fine abrasive grains are preferred.

*Keywords* Distributor; Fluidization; Roughness; SA-FBM; Swirling; Texture; Wear.

## Introduction

Swirling Abrasive Fluidized Bed Machining (SA-FBM) is a variant of Fluidized Bed Machining (FBM) composed of a bed of abrasive particles within an annular space and inclined passage of air through a specially designed distributor. FBM has already been successfully established as a surface finishing method to bring down the average roughness value of the machined components with grooves, ducts, channels, etc. SA-FBM has benefits over FBM such as adequate lateral mixing of abrasive particles, wide range of superficial velocity, reduced distributor pressure drop, effectiveness in fluidizing larger particles, improved particle kinetic energy and hence metal removal, and faster surface modification with improved surface finish.

The compressed air from the blower enters the plenum chamber and passes through the distributor (Fig. 1), which has small equally spaced inclined holes. The air entering the abrasive bed through the inclined holes facilitates fluidization by means of the vertical component ($v \sin \alpha$) and the swirling motion by the horizontal component ($v \cos \alpha$) of the velocity within the annular region of the cylindrical container. The material to be machined is placed in a suitable position inside the fluidized bed container within the annular space. The high-pressure air emerging out of the distributer fluidizes the abrasive grains accumulated over it. The fluidized abrasives hence lift up in the container, swirl vigorously within the annular space, and scratch the specimen surface, resulting in material removal and surface modification. The velocity of the abrasive grains can be varied by adjusting the airflow rate. Experimental setup constitutes a centrifugal blower to facilitate the supply of compressed air, venturimeter to measure the discharge of the air, and hence the superficial velocity of the abrasive media, flow control valve, distributer to facilitate the swirling fluidized flow, and a cylindrical container made of perplex glass in which the workpiece at a suitable angle is placed. A small cylinder is provided at the center to prevent the accumulation of abrasives at the center.

As reported by Barletta [1] in FBM, the shading effect of the workpiece can prevent a uniform finish for the whole machined surface as shown in Fig. 2(a). Bubbling abrasives show preferential abrasive action on the bottom part of the workpiece. This area is directly exposed to repeated impacts and is therefore actively machined as shown in Fig. 2(a), whereas the top portion of the specimen is only partially machined by less-energetic particles.

However, unlike the across-the-column bubbling of particles in fluidized bed, in swirling fluidized bed Fig. 2(b), particles move in a circular path mainly confined to the bottom portion, as reported by Sreenivasan and Raghavan [2]. Obviously the particles in swirling fluidized bed attain much more velocity and move with more increased concentration than the bubbling fluidized bed in the case of FBM. The horizontal component $V \cos \alpha$ ($\alpha = 15$–$20°$) of jet velocity, passing through the inclined openings of the distributer, imparts the circular motion horizontally as discussed earlier. Since the machining effect is proportional to the velocity of impact and the number of strikes per unit area on the specimen at an instant, SA-FBM can perform faster metal removal and surface modification for a given air discharge.

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Address correspondence to N. K. Francis, Nedumpakaran House, P. O. Kuruvilassery, Mala, Thrissur, Kerala, India; E-mail: francisnk123@gmail.com

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