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INNOVATION TOOL USING TAGUCHI-METHODS FOR DEVELOPMENT OF A NEW PRODUCT WITH OPTIMUM CONDITION

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Abstract. As a development with short-term and lower cost is strongly required in 21st century. Therefore the innovation tool using Taguchi-methods [1], [2] for development of a new product with optimum condition was developed and evaluated. Flow-chart of the innovation tool using the Taguchi-methods is shown in Figure 1. The tool consists of two trials using the Taguchi-methods; these are "First trial for selection of the several important parameters" and "Second trial for decision of the optimum condition". In the First trial, all levers of all control factors should try for the final properties or the final functions. This trial is for picking out the important parameters and for throwing away the meaningless parameters. If difference of influence on the each level regarding a control factor in the effective figure of "the Sensitive" is very little, the control factor is judged to the meaningless parameter. And when SN ratio is very small, the level of the control factor is judged to low robustness. Only important parameters selected in the First trial are used in the Second trial. In this trial, each

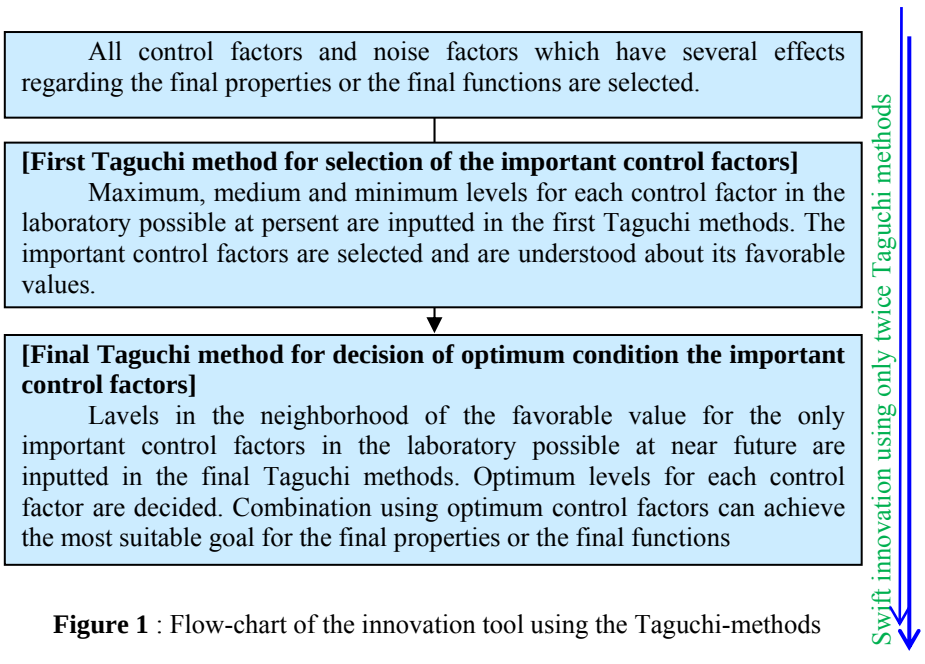

Figure 1 : Flow-chart of the innovation tool using the Taguchi-methods

important parameter is checked in more detail. If the important parameters require the larger or smaller level of a control factor for optimum condition, the new equipment for the larger or smaller level of the control factor is supplied in here. And if the important parameters require the level with high precision of the control factor for optimum condition, the new equipment with high precision is also then supplied in here. This second trial becomes the final trial, because optimum condition is decided in the second trial using innovation tool using Taguchi-methods with the best condition in the laboratory. This new method will be more proper than the conventional Taguchi-methods [3] or other methods [4],[5] for searching the optimum condition.

The optimum condition for polishing a minute die was investigated for evaluating this innovation tool in the experiment. Polishing tool and polishing procedure are shown in Figures 2 and 3, respectively[6]. This polishing tool consists of the pipe and the ball head with

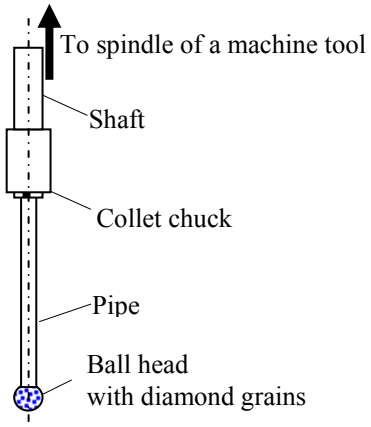

Figure 2: Schematic view of the polishing tool

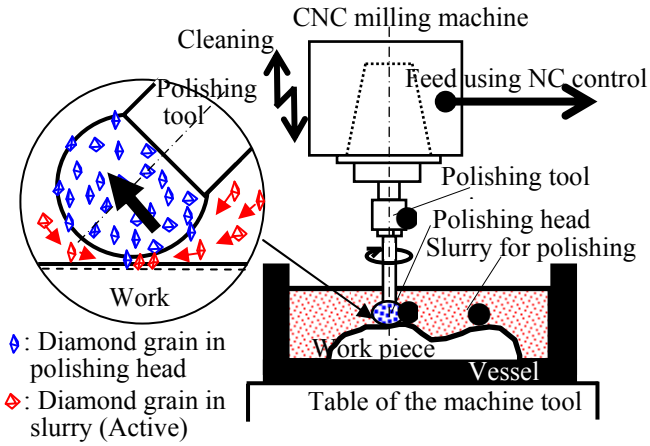

Figure 3: Schematic view of polishing (Principle)

Table 1: Best and worst conditions for the polishing

Polishing condition		Best condition	Worst condition
Spindle speed min^{-1}		10000	9000
Feed speed mm/min		0.5	0.7
Polishing pressure MPa		140	100
Polishing pitch mm		0.3	0.2
Polishing tool	Material of polishing head (Ball head)		Epoxy resin
	Diameter of polishing head (Ball head)		ϕ 1.0 mm
	Diamond grain in ball head (＃=Mesh size)		#2500
	Pipe		0.7 mm
Slurry	Base liquid		Water
	Diamond grain in slurry (＃=Mesh size)		#2500
	Rate of grain (slurry : diamond)		10 wt% (9:1)
	Ratio of PEO (Poly-ethylene-oxide) for water		2 wt%
Work piece			Carbide

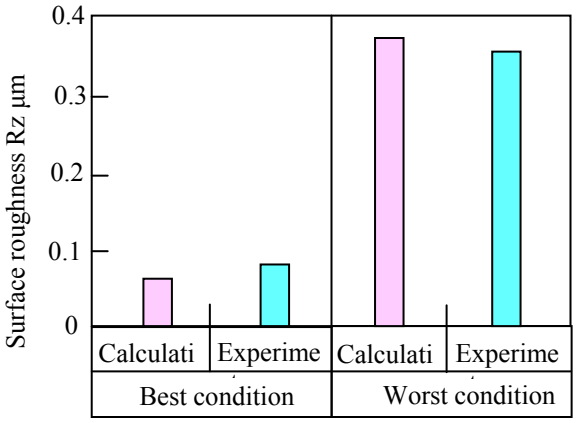

Figure 4 : Surface roughness of the polishing with best and worst conditions
(By the innovation tool using Taguchi-methods)

diamond grains. Base material of the ball head is epoxy resin. Slurry consists of water, a polymer and diamond grains. The polishing tool is installed on the spindle of CNC milling machine, is rotating and moving in three dimensional directions by NC control. Several diamond grains in the polishing head and in the slurry can cut on the work piece. The polishing trace becomes very shallow because of soft ball head. However surface roughness of the work piece becomes very small because of shallow trace. After all, the polishing tool can polish to mirror-like surface. Particularly the ball head of the polishing tool has small diameter which is smaller than 1 mm. Therefore the polishing tool can polish a minute die.

The optimum condition for polishing tool is evaluated in the experiment. Polishing condition used in the experiment is shown in Table 1. Work piece material is carbide. Specifications of the polishing tool and the slurry are similar to the previous experiment. Best and worst conditions in the Second trial are included for the polishing conditions.

Surface roughness of the polishing with best and worst conditions is shown in Figure 4. The results of the experiment are similar to the calculated results by the innovation tool using Taguchi-methods. The optimum condition for polishing tool was decided by only twice trials. Therefore the innovation tool using the Taguchi-methods was useful for development with short-term and lower cost.

It is concluded from the result that (1) Innovation tool using the Taguchi-methods was useful for development with short-term and lower cost, and (2) This tool could quickly and exactly decide the optimum polishing condition.

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