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comparaison of surface quality in turning process of AISI 1035 and AISI 12L14 steel

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Abstract: This experimental study is carried out within the Jms flexibles company in order to evaluate the effect of the cutting parameters in turning of AISI 12L14 and AISI 1035 steels. The experimental design method (ANOVA) was used to quantify the effects of cutting parameters on machine surfaces. A comparative study is carried out in order to determine the parameters that have the most influence on the microgeometry and the microstructure of surfaces machines in turning. The result is a minimum turning roughness at the two types of study steels for the combination (Vc, f and a)

Keywords: Roughness; turning; AISI 1035; AISI 12L14

Introduction

The complexity of machining is explained by the interaction between many phenomena including the behavior of the material to the machines, cutting parameters and tool wear [1,2]**.** The best machinability of AISI 12L14 steel has awarded the material wide range of many applications. Its success lies in the lead, phosphorus and sulphide particles, which insure breakable chips and self-lubrication [4]. Indeed, there are many interacting cutting parameters responsible for improving machinability. however, there are many research in turning of AISI 1035, such as the effect of the cutting parameters on the surface quality [5], multi-objective optimization techniques simplifying the problem into a single objective one were applied [6]. Machinability depends on the interaction tool - material - lubrication mode - cutting conditions and so forth [4]. Furthermore, there are many interacting parameters responsible for improving different machinability aspects including tool life, cutting force, surface finish and formation of small and stable built-up edges [7]. In all machining process, including turning, controlling the workpiece-tool interaction associated with the workpiece material is extremely difficult, especially when combining these parameters to study their effects on machinability and/or surface characteristics and their impact on service life [8]. Due to this complexity of combinations and their impact, we need to find a model for optimizing these parameters to expect a better quality and productivity. Generally, the quest is to optimize the cutting parameters, i.e. : cutting speed, feed rate and depth of cut, etc., in order to attain the minimum of surface roughness as an index of surface quality.
A comparative study of the machining of AISI 1035 and AISI 12L14 steels available for their different machinability is carried out based on experimental approaches verifying the effects of cutting parameters on chip formation and on the quality of finished surfaces by machining.

Experimental Methodology

Materials and Study Parts.

The machining range for the manufacture of the S13TBSP fitting in AISI 12L14, belonging to the **Jms flexible company**, compared to the same in AISI 1035. The machined surfaces of which are defined in Fig. 1. The chemical composition and Mechanical properties of the two study steels: AISI 1035 and AISI 12L14 are reported in Tables 1 and Table 2, respectively.

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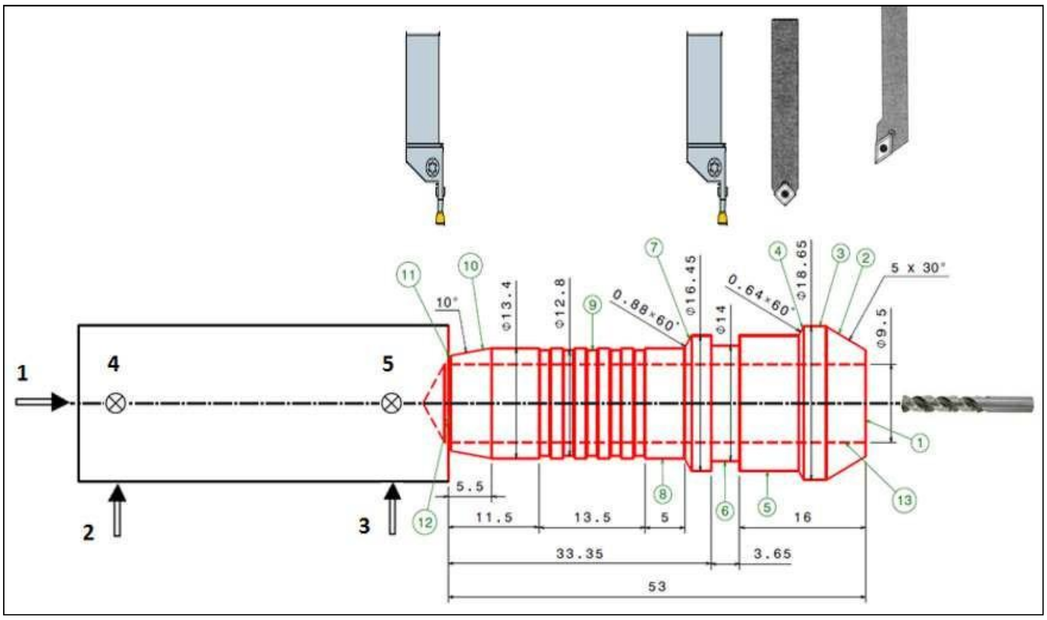

Figure.1. Drawing of the S13 TBSP fitting (***flexible Jms***)

Table 1. Chemical composition in % of AISI 1035 and 12L14 Steel

	C	Si	Mn	P	S	Pb	Fe
AISI 1035	0.14	0.05	1.2	0.09	0.36	0.3	Balance
AISI 12L14	0.36	0.40	0.06	0.035	0.035	-	Balance

Table 2. Mechanical properties of AISI 1035 and 12L14 Steel

	Rm [MPa]	Re [MPa]	A (%)	Hardness [HV]	E [GPa]
AISI 1035	550	300	18	319	207
AISI 12L14	650	400	8	200	207

The machining operations are carried out on sockets and fittings intends for the connection of composite pipes for AISI 12L14 steel using a machine tool of the MOCN CKT 613 type and cylindrical specimens with a diameter of 60 mm and a length of 200 mm for AISI 1035 steel.

Design and experimental methodology

The first step is to set up a behavior model of the machining process (turning). Many parameters can influence the surface condition of the workpiece; one can in particular quote the cutting conditions: The cutting speed (Vc), the feed rate (f) and the depth of cut (a). Indeed, the corresponding factors were chosen in Tables 3.

Table 3. Cutting conditions used for AISI 12L14 and AISI 1035

	Level	Vc (m/min)	f (mm/tr)	a (mm)
AISI 12L14	Low	125	0.1	1
		175	0.2	2
	High	195	0.3	3
AISI 1035	Low	125	0.1	1
	Way	175	0.2	2
	High	195	0.3	3

The experimental design method (Taguchi) was used to identify the machining conditions leading to minimum roughness. The results shown in Tables 4.

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Table 4. **Standard Taguchi table for AISI 12L14**

Tests	Independent variables			Roughness Ra (µm)	
	Vc (m/min)	f (mm/tr)	a (mm)	AISI 12L14	AISI 1035
1	125	0.1	1	1.94	2
2	125	0.2	2	3.49	3,8
3	125	0.3	3	4.8	6,2
4	175	0.1	2	1.95	3,4
5	175	0.2	3	3.2	2,6
6	175	0.3	1	3.97	3,7
7	195	0.1	3	1.95	3,3
8	195	0.2	1	2.1	1,9
9	195	0.3	2	3.18	3,8

Quality and Integrity Characterizations Tests of Machined Surfaces

The machining operations were carried out by two types of inserts intended for finishing turning :CNMG 12 04 12 PM for turning dressing and MGMN 300-G SMM 302 for parting in the case of AISI 12L14 steel. The quality of the machined surfaces is evaluated by measuring the roughness parameters Ra. The micro geometric state, which is analyzed using a linear roughness of the surftest SJ-210-Mitutoyo P/ M type.

Results

Effect of Cutting conditions on the Micrometric State of AISI 12L14 Steel

The change in roughness as a function of the cutting parameters (Vc, f and a) in turning of AISI 12L14 steel shows significant effects of each of these parameters (Fig.2)

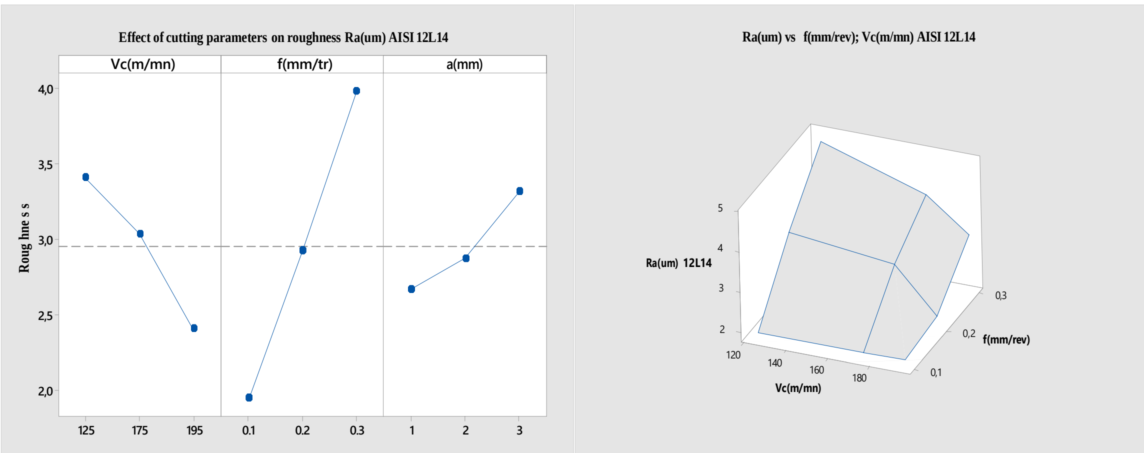

Figure.2. Evolution of the roughness Ra as a function of the cutting conditions (Vc, f and a) of AISI 12L14 steel

Effect of cutting parameters (f, Vc and a) on the AISI 12L14 surface roughness Ra

Fig. 3 shows the direct and significant influence of the feed rate f on the roughness Ra measured on AISI 12L14 steel specimens The lead is the determining factor in the quality of machined surfaces This is explained by the formations of helical grooves resulting from the shape of the tool and the helical movement of the tool to the part. These furrows are as deeper and wider as the feed rate is high, hence the need to use small feeds when finishing turning (Fig. 3).
Analysis of these results explains that during machining, the roughness of AISI 12L14 steel decreases slightly with increasing cutting speed up to 195 m/mn .This improvement is explained by the fact that the material is ductile and the selected cutting speeds are high So there is no

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degradation of the surface finish by the adhesion of particles or fragments of the chip on the already machined surface (Fig. 3).
Note that the depth of cut is not a main parameter for the quality of the surface finish. However, the value of Ra changed slightly with increasing depth of cut. This evolution is surely due to an imbalance of the tool during the increase of the depth of cut, as well as to probably higher cutting forces influencing the stability of the machining system and leading to the vibratory effects, which generates an increase in roughness.
The graph of the effects of interaction corresponding to the average affects calculated according to the level of another factor Confused curves reflect zero interaction ; very different curves reflect a strong interaction (Fig. 3)

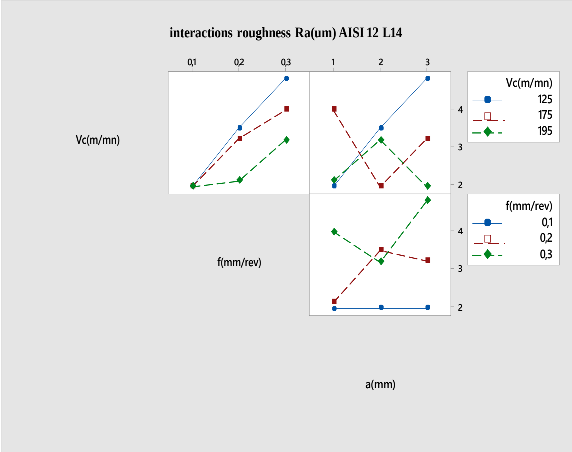

Figure.3. AISI 12L14 interaction effects graph

Effect of cutting conditions on the micro-geometric state of AISI 1035 steel

The change in roughness as a function of the cutting parameters (Vc, f and a) in turning of AISI 1035 steel, shows significant effects of each of these parameters (Fig. 4).

Analysis of these results explains that during machining, the roughness of AISI 1035 steel decreases slightly with increasing cutting speed up to 195 m/mn
Fig.4 illustrates the results of the change in roughness as a function of the feed rate. Analysis of the curves shows that this parameter has a very significant influence on roughness. In fact, the feed rate is the determining factor in the quality of machined surfaces, in turning for example, the surface generated includes helical grooves resulting from the shape of the tool and the helical movement of the tool-to-part.
From Fig. 4, it can be seen that the roughness of AISI 1035 steel increases with increasing depth of cut.

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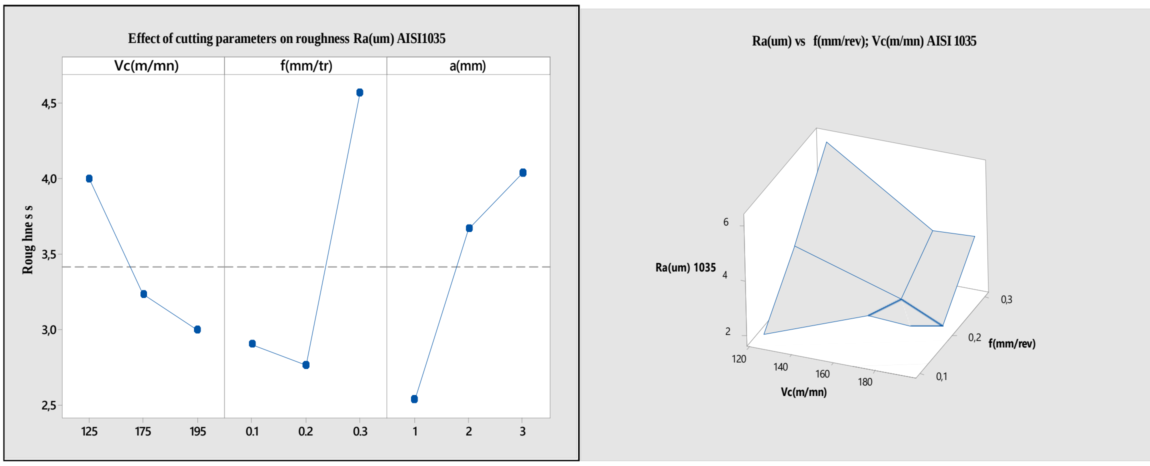

Figure.4. Evolution of the roughness Ra as a function of the cutting conditions (Vc, f and a) of AISI 1035 steel

The graph of the effects of interactions corresponding to the average effects calculated according to the level of another factor, confused curves reflect zero interaction; very different curves reflect a strong interaction (Fig. 5).

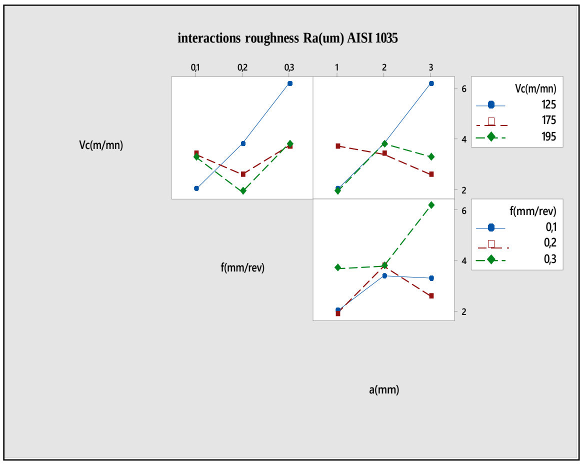

Figure.5. AISI 1035 interaction effects graph

Comparison of the surface conditions of AISI 2L14 and AISI 1035 steels

The experimental results in figure 6 show the influence of cutting speed on the tourning roughness Ra of the two materials. Analysis of these results explains that during machining, the roughness of AISI 12L14 steel decreases slightly with increasing cutting speed up to 175 m/mn. However, the reduction in machining roughness of AISI 1035 steel is greater than that of AISI 12L14 steel.

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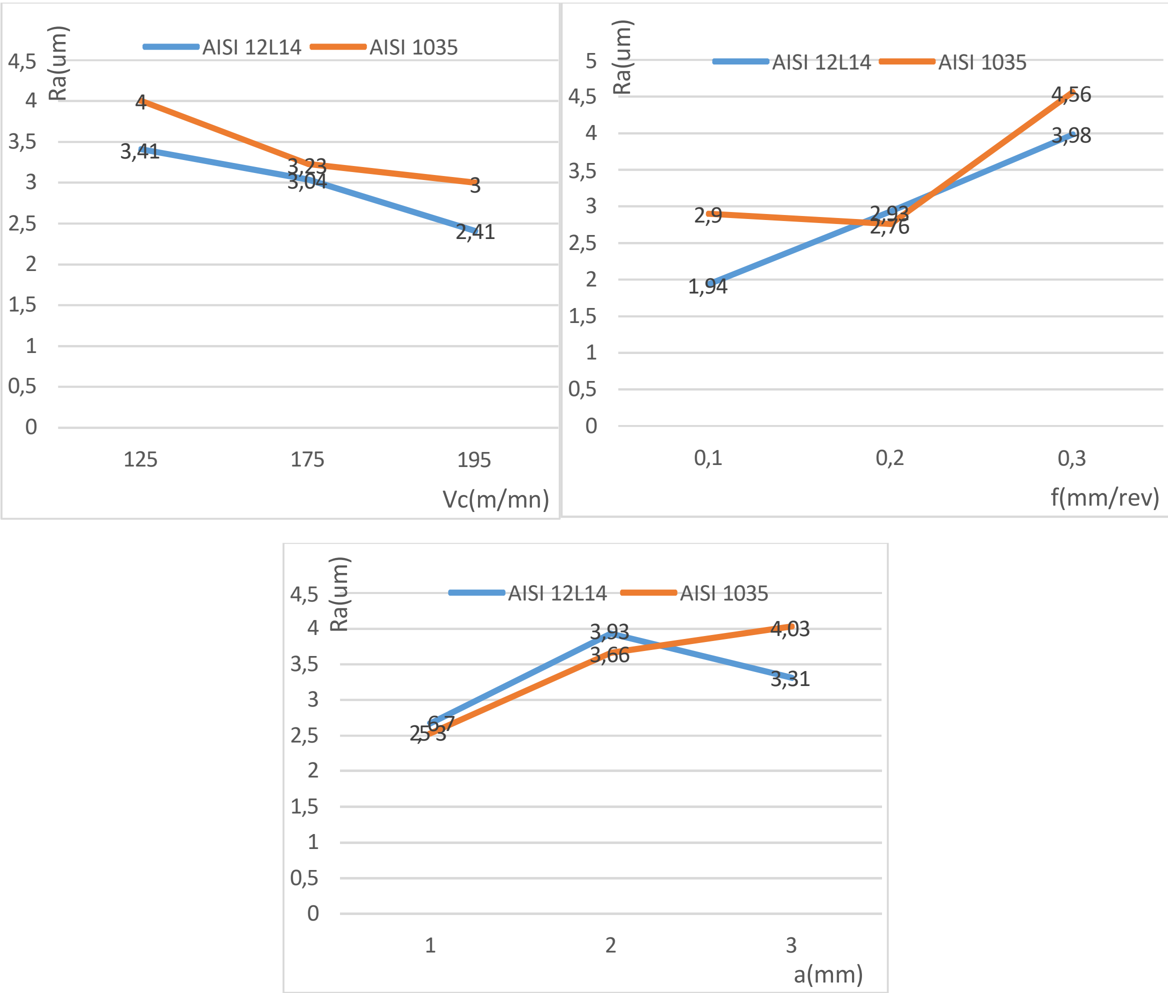

Figure.6. Graphs of the effects of cutting parameters on the roughness of AISI 1035 and AISI 12L14 steels

These results show that machining AISI 12L14 steel gives a better surface quality than that obtained when machining AISI 1035 steel. Increasing the cutting speed improves the quality of the machines surface of the two machines steels. On the other hand, increasing the feed per revolution or the depth of cut leads to a deterioration in the surface quality.

Conclusion

The effect of the cutting parameters in turning on the roughness of finishing surfaces of AISI 1035 and AISI 12L14 steels show that the arithmetic roughness is 1.9 µm for AISI 1035 steel at a cutting speed Vc=195 m/mn, a feed rate f=0.2 mm/rev and a depth of cut a=1 mm.

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