Optimization Of Twin Screw Extruder (Tse) Machine For Polyethylene Terephthalate (Pet) Polymer Material Using Anova Methods
A Review

Nikunj K Limbachiya[1]*, H.R.Prajapati[2]*

1* M.Tech student, U. V. Patel College of Engineering,

2*Assistant Professor ,Mechanical Department, U.V.P.C.E.

Kherva, Mehsana, Gujarat, India

Abstract:

Multi objective evolutionary algorithms have already been used for the optimization of the processing conditions of a co-rotating twin screw extruder. Twin screw extruder machine (TSE) for polyethylene terephthalate (PET) polymer material. This extruder techniques used in some product like that food making process, PVC polymer pipes etc. In the present paper, we develop this approach for the optimization of the screw geometry, effects of twin screw extrusion parameters on mechanical test. These attributes are narrowly related to, and affected by, the process parameters. A 3-level–4-factor factorial experimental design was used to investigate the influence of screw speed, barrel temperature, feed rate. We are studies some review paper and testing some mechanical properties of specimens were measured by means of tensile test, flexure test.

Keywords: Optimization techniques (PLS, ANOVA), effects on input parameters is screw speed, barrel zone temperature

1. Introduction

In extrusion operation, two different extrusion process of one is single screw extruder process or another is twin screw extruder process, in twin screw extruder process in PET polymer material uses, in which Co-rotating twin screw extruders are extensively used in the polymer compounding industry mainly due to their good mixing capacity. Given its modular construction, this type of machines can easily be adapted to work with different polymeric systems, e.g., polymer blends, nano composites or highly filled polymers. In which extrusion process to solve by different methods of algorithms we consider the optimization goals average strain, specific mechanical energy (SME) and viscous dissipation. This problem we scaling-up as a multi-objective optimization problem where the aim is to define the operating conditions of the target extruder that minimize the differences between the values of the performance criteria that depict the reference and target extruders. Similar strategies were adopted to design co-rotating twin screws.

1.1 Optimization methodology used for (TSE)

A Clextral 21.25 twin screw extruder was used as reference while a Leistritz LSM 30.34 was selected as target twin screw extruder machine. A polyethylene terephthalate (PET)is being processed in the Clextral machine with a flat barrel temperature of 220ºC, a feed rate of 8 kg/hr. and a screw speed of 200 rpm. In this method to we are solve effective parameters runs for PET polymer strap material and we get some experiments details from a literature paper, so we explain some experiments details related to twin screw extruder machine for PET polymer material by various optimization methods.

2 Effective experiments parameters by experiments.

➢ Screw speed.

➢ Barrel temperature.

2.1 Experiments:

Here we have focused on some investigators' experiments.

B TRIPALO, D JEZEK, D SEMENSKI, et al.(2011) have been investigated the effect of twin screw extruder machine experiments parameter screw speed, barrel temperature, moisture content, feed rate and all its parameters to solve by 3-level 4-factors factorial method experimental design. Screw speed, barrel temperature and moisture content, feed rate are found to have significant effect on the twin screw extruder machine. Feed moisture content has a positive effect on extruder hardness, and screw speed and barrel temperature have negative effects. **[1]**

Table 1 Experimental design and observed experimental data

n	T [c°]	MC [%]	r [kg/h]
150	120	24·5	40
150	170	24·5	40
150	120	24·5	20
300	170	24·5	20
300	120	24·5	40
300	170	24·5	40
150	120	18.3	20
150	170	18.3	20
150	120	18.3	40
300	170	18.3	40

| 300 | 120 | 18.3 | 20 |
| 300 | 170 | 18.3 | 20 |

[n- Screw speed, T – temperature, MC– moisture content, r – feed rate,]
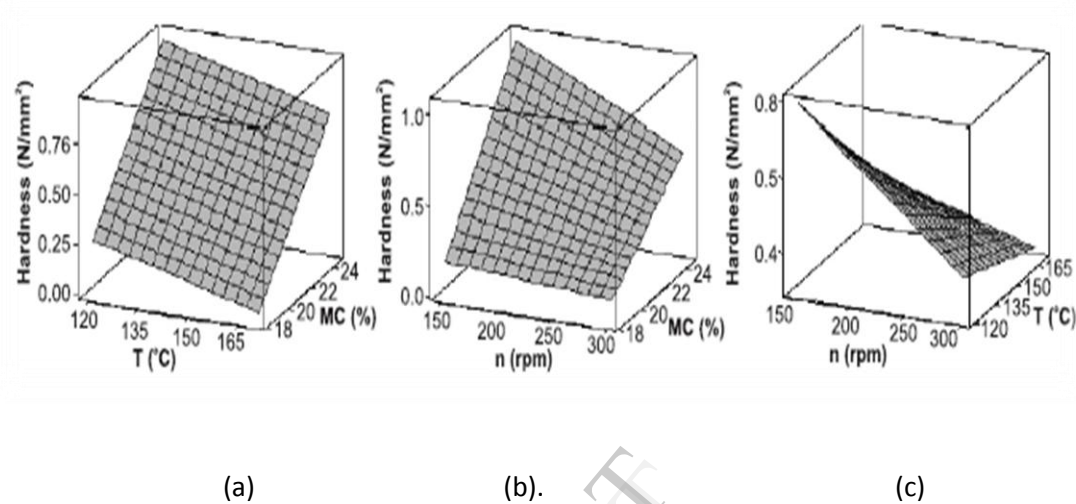

(a)   (b).   (c)

Figure 1 (a) Influence of T and MC on hardness of extruder at screw speed 225 rpm.(b) Influenceof n and MC on hardness of extrudate at temperature 145◦C. (c) Influence of n and T on hardness ofextrudate at moisture content 21.4%

Antonio Gaspar-Cunha, Jose A et al. (2011) have been solve the single-twin screw extruder by Optimization algorithm multi-objective genetic algorithm, denoted as RPSGA was used to select the operating conditions and to design screws that optimize the performance of single-screw and co-rotating twin-screw extrusion, which are important industrial processing technologies. These correspond to complex multi-objective, combinatorial, not always continuous problems. **[2]**

Table 2.Criteria for optimizing twin-screw operating conditions and corresponding range of variation

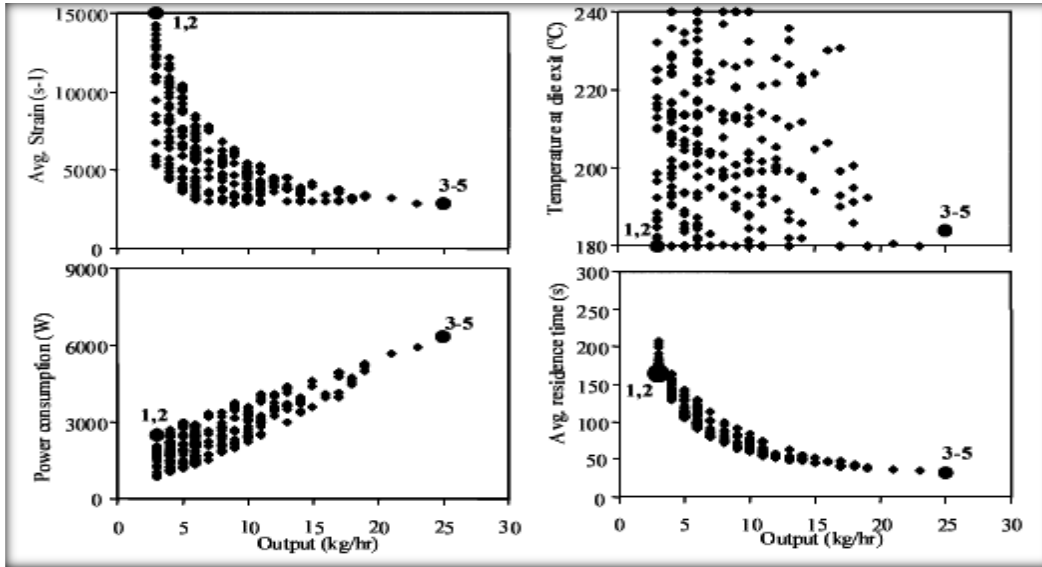| Criteria	Aim	Range of variation	
C1-Output (kg/hr)	Maximize	3	20
C2-Average strain	Maximize	1000	15000
C3-Melt temp at die exit (c°)	Stay within range	180-210	220-240
C4-Power consumption (kw)	Minimize	0	9200
C4- average residence time (s)	Minimize	10	300

Figure 2 Pareto frontiers on the criteria domain after the optimization of the operating conditions.

Krzysztof Jan et al.(2010)have been experiment of Polymer Single Screw Extrusion with Metered Feeding, this two parameters were used for experiment, in also studied to input parameters were feed rate, screw speed and output parameters were extrusion output, melting behavior of the polymer, and pressure as well as temperature profiles. From experiments results he conclude that both polymers that the filled length increases with the flow rate at a fixed screw speed, and decreases with the screw speed at a fixed flow rate. **[3]**
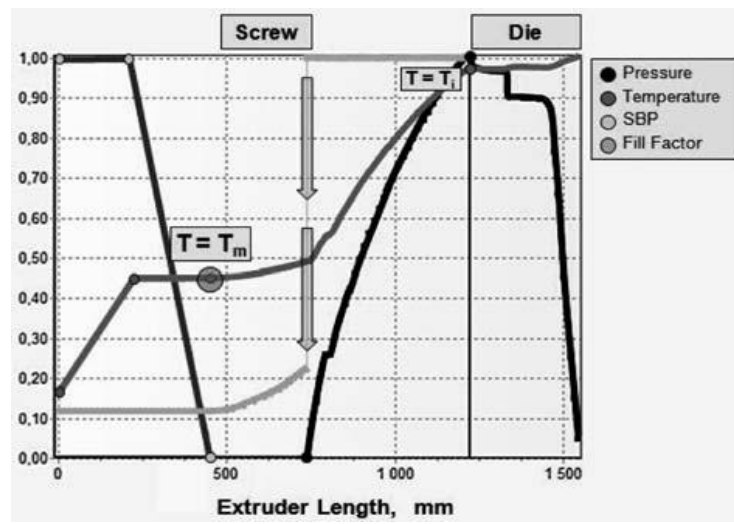

Figure 3 Algorithm of modeling for starves fed single screw extrusion.

Eduardo L. et al. (2009) have found out Computer Simulation of plastics compounding operation in twine screw extruders is concerned with the development of process simulators for the analysis of compounding operations in modular co-rotating intermeshing twin-screw extruders. In this paper he is discuss to one-dimensional lumped-parameters methods, in which the equations of motion are integrated (based on simplified flow models) throughout the cross section, are very fast, versatile, and easy to use. Their only drawback is their relative lack of accuracy and resolution (i.e., the level of detail) and this can be overcome, at least in part, by the use of extensions and modifications. In this presentation they had been discuss only simulators based on one dimensional models, they have used The models must be translated into numerical algorithms, and the algorithms translated (coded) into a computer program and he conclude that selection of modeling techniques allows the development of fast, versatile, and reasonably accurate process simulators for the analysis of plastics compounding operations in twin-screw extruders. **[4]**
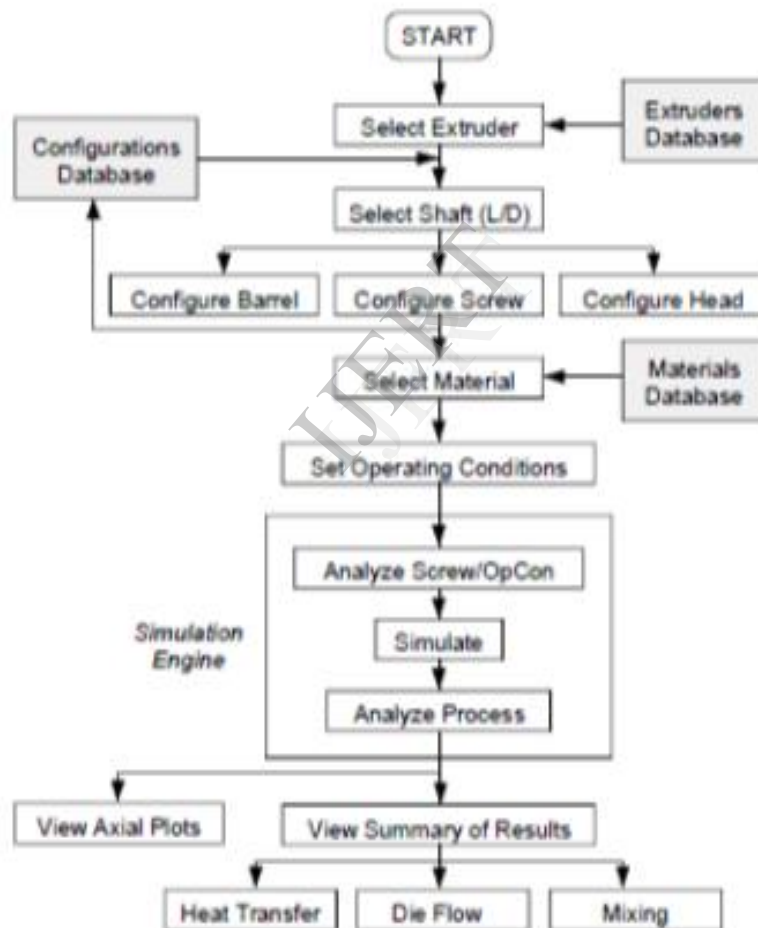

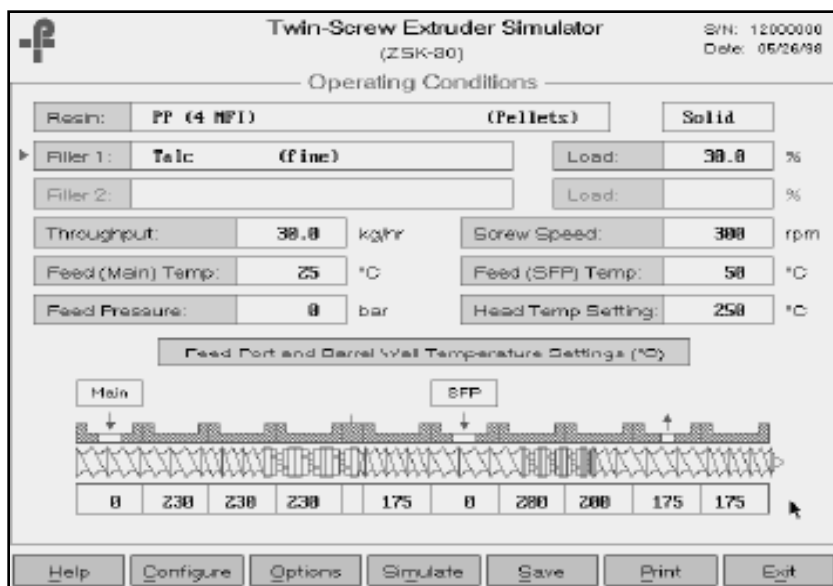**Figure 4 Algorithm run in Twin-Screw-Extruder Simulator (TXS)**

Figure 5 Typical Operating Conditions screen

M.H.N Famili. et al. (2008)have been investigated Fast and Economical Method for Producing of Self-wipe Twin-screw Extruder Modules in After the extrusion process the remaining of polymers in the extruders cause some problems like degradation and impurity in process, therefore after each batch the extruder should be cleaned. Using self-wipe twin-screw extruder is a method. In this research to found out we have presented a novel, quick and economical method for producing self-wipe modules with desirable profiles. studied self-wipe, intermeshing co-rotating screws shape and size by CNC lathe machine so that its use experiments of Fabrication of self-wipe modules by using of common and CNC lathe machine is not possible The prepared screw by these machines may be improved with burnishing to make them similar to the self-wipe profile, but they cannot act as self-wipe modules. Main advantages of this research The maximum wiping efficiency of the modules prepared with conventional method is about 70% of prepared self-wipe modules with this new method needed for preparing of self-wipe modules with this new method is about 10% of the conventional method.**[5]**

Figure 6 Screws prepared by lathe machine-by using of mould

Figure 7 The final modules of the self-wipe screw prepared with Lathe machine by using Special cutting tool shape

Gaspar, J. A covas. et al.(2009) have been Multi-objective EAs have been used for the optimization of the screw geometry of a co-rotating twin screw extruder. The problem consists in finding the most adequate location of a pre-selected set of screw elements, in order to maximize a prescribed performance. Experimental validation has shown the potential of this approach, which is more rapid and less expensive than the classical trial and error procedure. However, improvements in process modeling are still necessary, namely in what concerns mixing, for practical application of the method for compounding operations. The next important step in the algorithm is to provide the possibility of finding the location of screw elements that maximize the prescribed performance from a wider set of available elements, which corresponds to the practical problem in industry.**[6]**
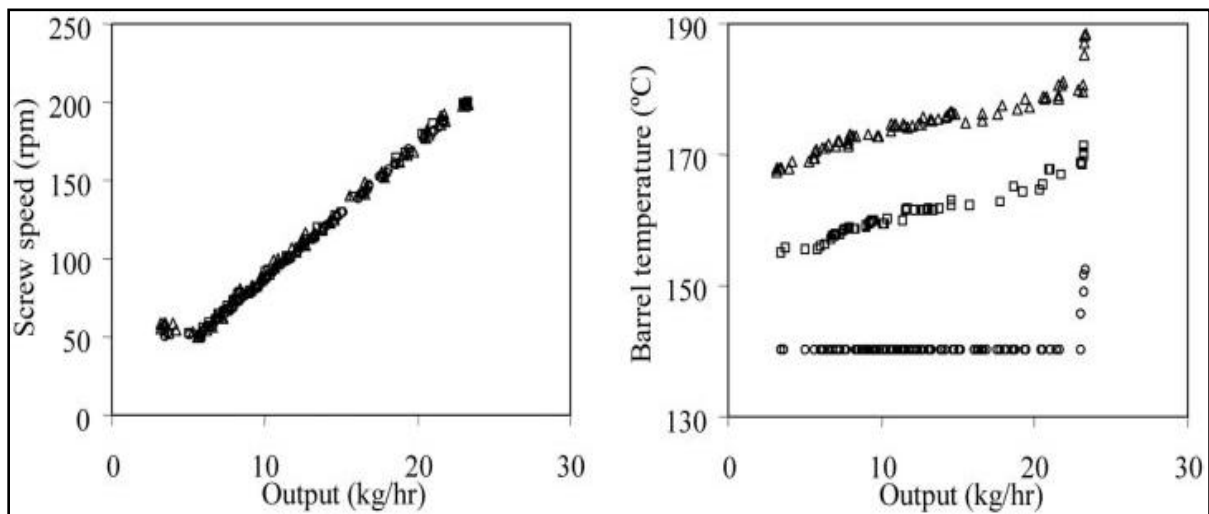

Figure 8 Optimal Pareto frontiers in the criteria and variables to optimize domains, for polymerization.

Nelson Lorca, Jr. et al. (2009) have investigated of effect of extrusion parameters on two material Blends of poly (butylene terephthalate) (PBT) and acrylonitrile butadiene styrene (ABS) the brittle-to-ductile transition temperature (BDTT) of PBT/ABS blends is relatively high (approximately -10C°) We found achieved a blend with the lowest BDTT (-53C°) using the reactive compatibilizer MGE and a combination of processing parameters characterized by a screw rotation speed of 120rpm, large kneading blocks, a feed rate of 7.0kg/h, and MGE incorporation in the fifth extruder barrel. Also we solve Izod impact strength. **[7]**
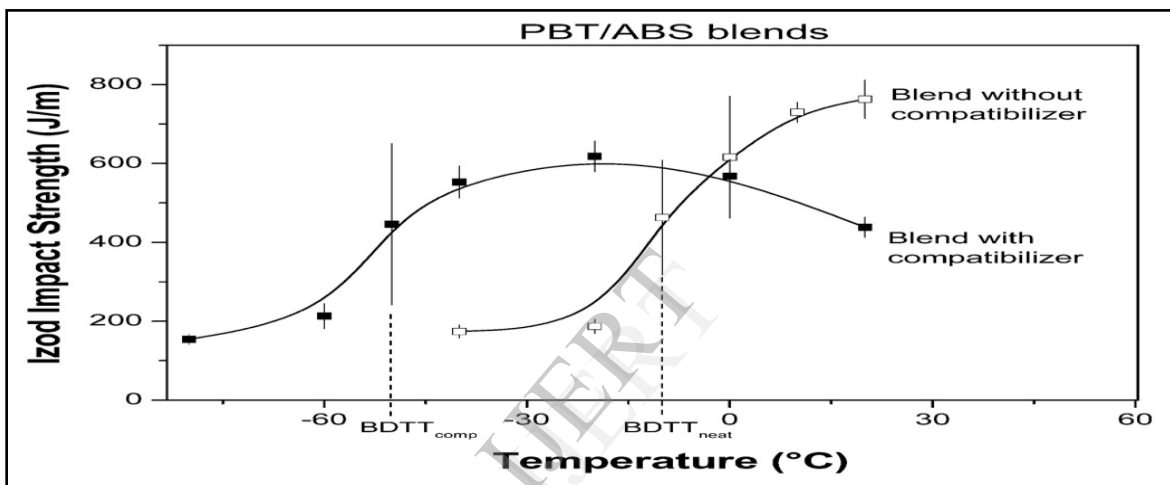

Figure 9 Notched Izod impact strength (a standard method of determining impact strength) Vs temperature for neat poly(butylene terephthalate) (PBT)/acrylonitrile butadiene styrene (ABS) `and blends with 5% by weight (wt%) of methyl ethylacrylate–glycidyl methacrylate-ethyl acrylate reactive compatibilizer. Both blends have the same ABS content (30 wt%). They were processed in an intermeshing twin-screw extruder at a screw rotation speed of 120 rotations per minute (rpm) and a feed rate of 7.0kg/h. The extruder temperature was 240C°. BDTT: Brittle-to-ductile transition temperature.
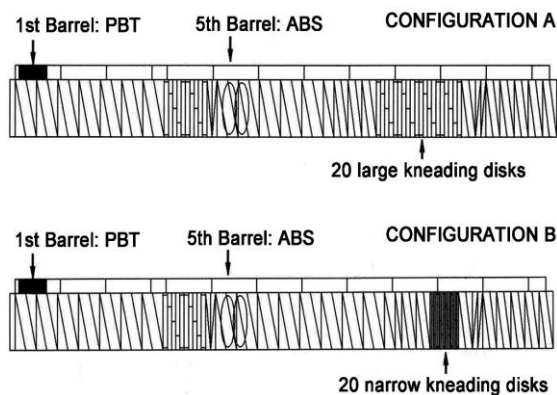

Figure 10. Configurations used to process the compatibilizer PBT/ABS blends. Configuration A: Screw with 20 large kneading disks in the mixing region (ninth barrel) Configuration B: Screw with 20 narrow kneading disks in the mixing region. We incorporated the PBT in the first and the ABS in the fifth barrel.MGE incorporation was done in either the first or fifth barrel.

3. Conclusion

Literature depicts that a considerable amount of work has been carried by out by number ofinvestigators for modelling, simulation and parametric optimization and Pareto Local Search(PLS) algorithm and testing material samples. We are find out improvement of screw configuration or increase productivity, The ability of TSE to produce high tolerance, complex profiles and net shaped products leaves the process well suited to many industrial tasks which is corresponds to solve the practical problem in industry.
For this project input parameters are

> ➢ Screw speed.
> ➢ Barrel temperature

And output of this some reiew is some data gives of power consumption and hardness of some mechanical properties and most effective on output parameter is tensile test, flexure test. using solution of twin screw extruder (TSE) machine for polymer material problem by optimization techniques.

4. References.

[1]   Hsieh, F. Peng, I.C. and Huff, H.E. (2010). Effects of PBT and screw speed on processing and product variables of corn meal extruded with a twin–screw extruder. Journal of Food Science 55, 224–227.

[2]   Lawton, B.T., Henderson, G.A. and Derlatka, E.J. (2011).The effects of extruder variables on the gelatinization of polymer effect. Canadian Journal of Chemical Engineering 50, 168–172

[3]   W. Hale, L. A. Pessan, H. Keskkula, and D. R. Paul, Effect of compatibilization and ABS type on properties of PBT/ABS blends, Polymer 40 (15), pp. 4237–4250, 1999, doi:10.1016/S0032-3861(98)00670-3

[4]   Guha, M., Zakiuddin, S. and Bhattacharya, S. (1998). Effect of barrel temperature and screw speed on rapid visco analyzer pasting beheviour or rice extrudates, International Journal of Food Science and Technology 33, 259–266 (2009)

[5]   C. Teixeira, J.A. Covas, and A. Gaspar-Cunha, A global modelling program for co-rotating twin-screw extruders," PPS 26 – Proceedings of the Polymer Processing Society Annual Meeting, (2010)

[6]   A Harlin, Quantitative analysis of twin screw extruder performance in stabilization pelletizing of HDPE resins, Polymer Eng. Sci, 36, 403 (1996)

[7]   C. Garcia O. Cordon, and F. Herrera. A taxonomyand an empirical analysis of multiple objective ant colony optimization algorithms for the bi-criteria TSP. European J. Oper. Res., 180:116–148, (2007)