ISSN: 2348 - 2117

International Journal of Engineering Technology and Computer Research (IJETCR)
Available Online at www.ijetcr.org
Volume 4; Issue 1; January-February-2016; Page No. 72-77

DESIGN, OPTIMIZATION AND FINITE ELEMENT SIMULATION OF DIE STRUCTURE IN PLASTIC INJECTION MOULD

J Sudha Pallavi*[1], P.Siva Subramanyam[2]

[1] M.Tech scholar, Dept. of Mechanical Engg, Nova college of Engineering, Vijayawada, India

[2] Associate Professor Dept. of Mechanical Engg, Nova college of Engineering, Vijayawada, India

sudhapallavi24@gmail.com

Abstract

A die is a comprehensive tool used in manufacturing industries to cut or shape material mostly using a press. Like molds, dies are generally tailored to the item they are used to create. Products made with dies range from simple paper clips to complex pieces used in advanced technology. The Aim of this thesis work is to optimize the weight and cost of the injection mold by removing undesirable materials and using low cost materials at non-stress region areas. A general large size model will be prepared to design the mold structure using theoretical method. Complete level of mold parts and assembly will be prepared to conduct analysis. Structural analysis will be conducted on mould to find stress locations and non-effective locations. Modifications will be done on mold according to obtained results. Finite element simulation will be carried out on modified mold for evaluation and various materials will be applied in ANSYS at non- stress affected areas to reduce the cost. Conclusion will be made from the obtained results along with comparison tables / charts.

Keywords: **Die, Finite element simulation, mold parts.**

1. INTRODUCTION

Air coolers also called evaporative coolers are used for cooling purposes. They are different from air conditioners in the sense air conditioners use refrigeration cycle principle whereas air coolers use the evaporation of water principle. There are five main evaporative cooler parts, with each of these being composed of other parts or pieces. The first part is the Blower which creates the airflow into and out of the cooler. Then there are the pads which filter and cool the air. These pads are attached to the side grill; this grill is supported with side grill pillars and a mounting stand for motor. And the final part is bottom tank used to store water. First, when the evaporative cooler is on, the pump circulates water from the tank of the cooler to the top. It filters down into the pads where some of it is absorbed, but what isn't absorbed is passed down to the tank of the machine again where it will repeat the cycle of being circulated again to the top. Some of the water will be evaporated from the pads and the circulating water will eventually be used up. So tank acts as a water reservoir in order to keep the pads damp if the pads ever dry out, the cooler will not be able to cool the air. We have taken up the parameters of an already prepared air cooler and prepared a model for air cooler tank. And that mould tool design is done based on the model, by using CREO 2.0(PRO/ENGINEER) software. After determining the values of the mould tools, manufacturing drawings are prepared with full details selecting the appropriate materials. Subsequently, these mould tools are manufactured as per drawing prepared and subjected to quality control tests.

2. MOULD CALCULATIONS

In the analysis, both process parameters and the design of the mold are taken in consideration. A procedure has been developed, i.e. a method and a program code, which enables optimization of different quantities, not only restricted to injection molding simulation, by altering different variables. There are many ways to interpret the word optimization". In this work, "optimization" means the use of mathematical algorithms in order to maximize or minimize any given quantity.

Clamping Tonnage

$F_c=P_c\times A_p\times n$

F_c = clamping tonnage. (Tons)

P_c = Cavity pressure = 550 Kg/ cm2 =55 kg/ cm2

A_p = projected area = 1.3477369 m^2 = 13477.369 cm^2
n = no. of cavity =1
F_c = 55 kg/cm2×13477.369 cm^2×1
= 741255.295 kg = 741.255 tons
Available tonnage = 1103
As per machine standards = 1103 tons
= 1103×0.85:- = 937.55 tons
741.255T<937.55T
J1000AD (JAD series)
Mold height = 500 to 1200 mm
Based on the shot capacity
Shot weight = 635×density of PA-6/density of PS
= 635×(1.45/1.05)
= 876.3 gm
Considering the Factor of safety 85% only
= 876.3×0.85 = 744.855
Cooling calculations
Q = Heatto be transferred per hour by plastic Material
Q = M_p×a Cal /hr
M_p = Mass of plastic Material injected into mold per hour in gms/hr
a = heat content of plastic in Cal/gm = 5^0
M_p = Shot weight × no.of cycles per/hr
No. of cycles per /hr
59.90sec/comp filling time = 60 sec
Ejection time = 30 sec
3600sec/hr/90 per/comp = 40 comp
M_p = 744.855×40 = 29794.2
Q = 29794.2×130
Q = 387324.6 Cal/hr
Q_w = Rate of heat to be extracted by water in Cal/hr
K = the constant to allow heat transfer efficiency
M_w = Mass of water circulated in gms / hr
$Q_w = M_w \times K(t_{out} - t_{in})$ 5^0
For direct cooling method = 0.64
Indirect method = 0.50
$Q_w = M_w \times K(t_{out} - t_{in})$
= Q/2
M_w = 1716000/2×0.64×5
= 268125 gm/hr

3. MODELLING

Computer Aided Design (CAD) is a technique in which man and machine are blended in to problem solving team, intimately coupling the best characteristics of each. The result of this combination works better than either man or machine would work alone , and by using a multi discipline approach, it offers the advantages of integrated team work. The advances in Computer Science and Technology resulted in the emergence of very powerful hardware and software tool. It offers scope for use in the entire design process resulting in improvement in the quality of design. The emergency of CAD as a field of specialization will help the engineer to acquire the knowledge and skills needed in the use of these tools in an efficient and effective way on the design process. Computer Aided Design is an interactive process, where the exchange of information between the designer and the computer is made as simple and effective as possible. Computer aided design encompasses a wide variety of computer based methodologies and tools for a spectrum of engineering activities planning, analysis, detailing, drafting, construction, manufacturing, monitoring, management, process control and maintenance. CAD is more concerned with the use of computer-based tools to support the entire life cycle of engineering system.

© 2016 IJETCR. All Rights Reserved.

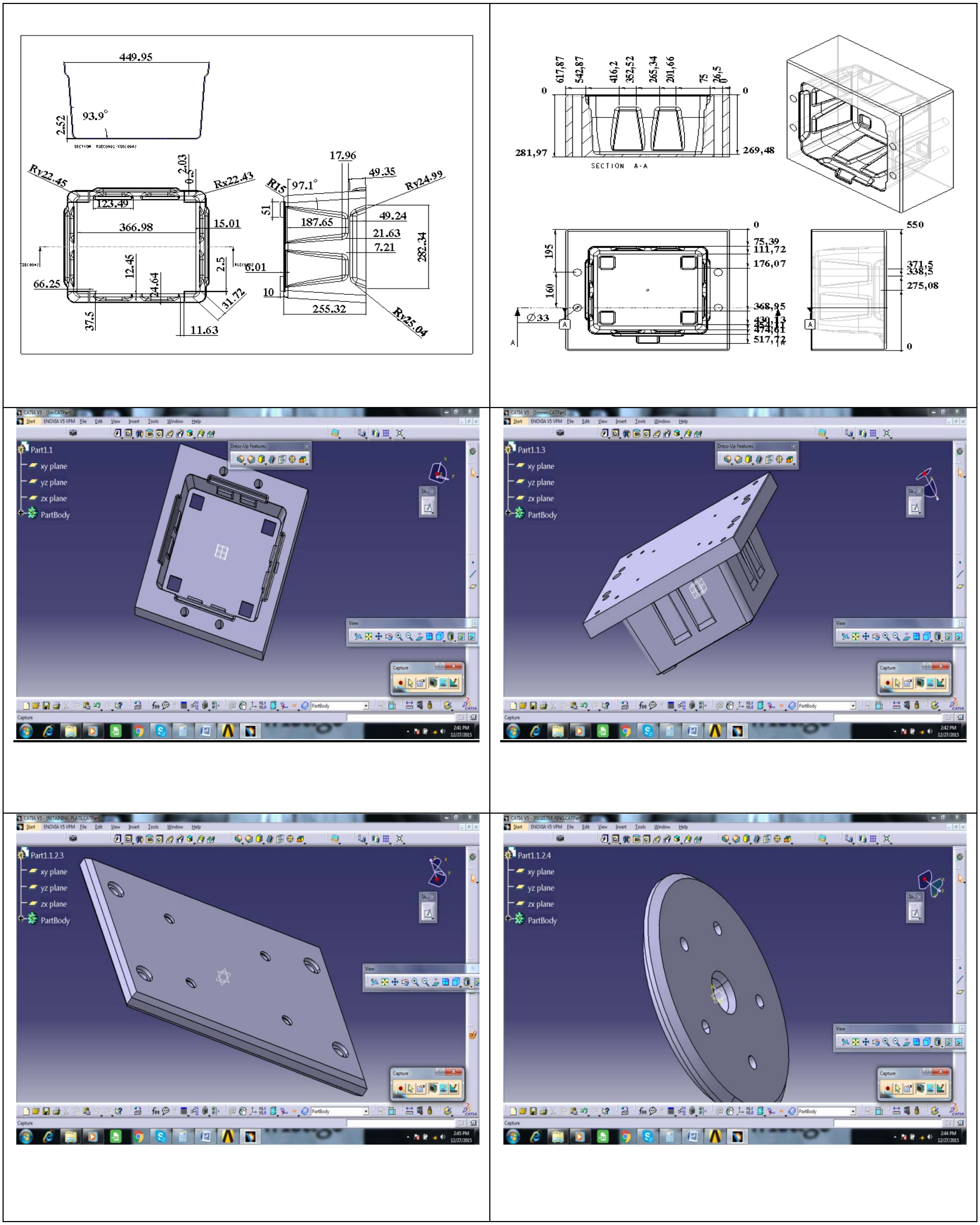


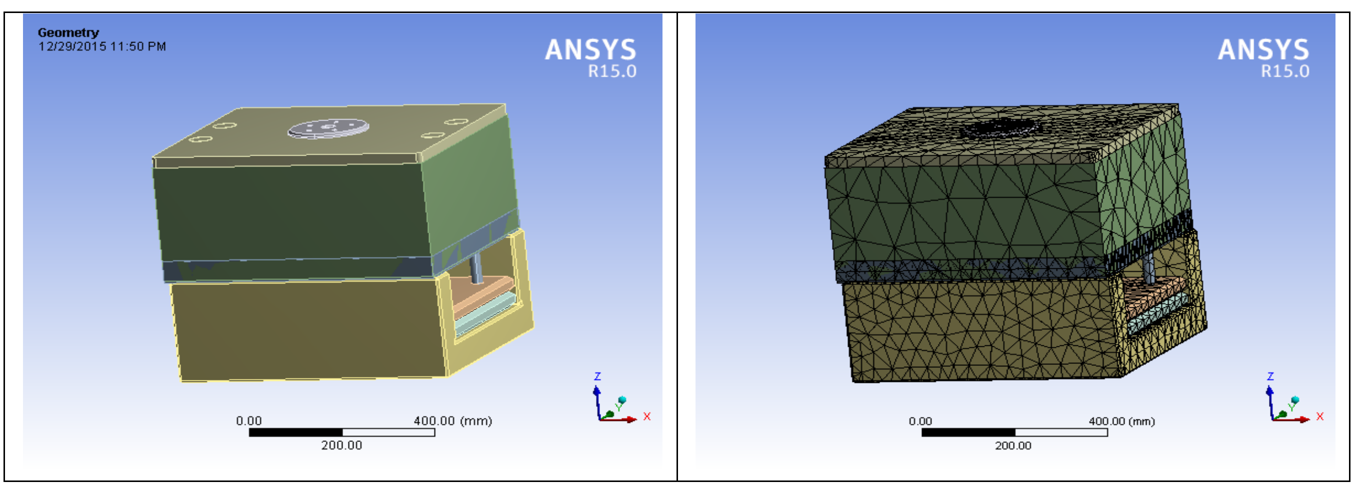
Figure 1: CATIA Images along with 2D drawings for cooler tank.

© 2016 IJETCR. All Rights Reserved.

4. Finite element analysis

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures". By the early 70's, FEA was limited to expensive mainframe computers generally owned by the aeronautics, automotive, defense, and nuclear industries. Since the rapid decline in the cost of computers and the phenomenal increase in computing power, FEA has been developed to an incredible precision. Present day supercomputers are now able to produce accurate results for all kinds of parameters. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client's specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition. There are generally two types of analysis that are used in industry: 2-D modeling, and 3-D modeling. While 2-D modeling conserves simplicity and allows the analysis to be run on a relatively normal computer, it tends to yield less accurate results. 3-D modeling, however, produces more accurate results while sacrificing the ability to run on all but the fastest computers effectively. Within each of these modeling schemes, the programmer can insert numerous algorithms (functions) which may make the system behave linearly or non-linearly. Linear systems are far less complex and generally do not take into account plastic deformation. Non-linear systems do account for plastic deformation, and many also are capable of testing a material all the way to fracture. A modal analysis is typically used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a harmonic response or full transient dynamic analysis.

Modal analyses, while being one of the most basic dynamic analysis types available in ANSYS, can also be more computationally time consuming than a typical static analysis. A reduced solver, utilizing automatically or manually selected master degrees of freedom is used to drastically reduce the problem size and solution time. 5.2.9 Harmonic Analysis Used extensively by companies who produce rotating machinery, ANSYS Harmonic analysis is used to predict the sustained dynamic behavior of structures to consistent cyclic loading.



© 2016 IJETCR. All Rights Reserved.

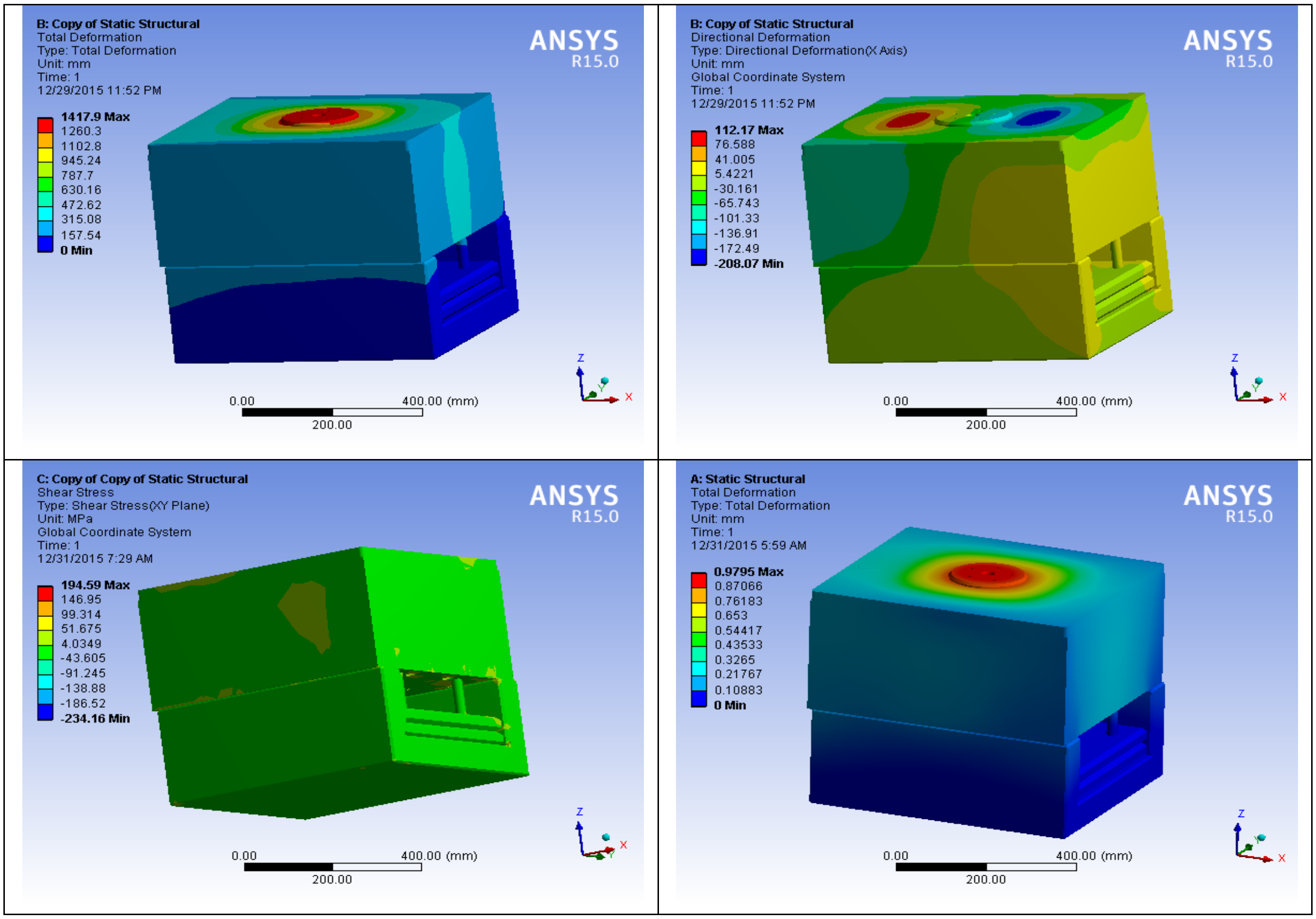


Figure 2: Finite Element Analysis of for cooler tank with varying materials.

5. RESULTS AND DISCUSSIONS

For the material specification of the EN38, MILDSTEEL and OHNS die the static analysis is performed to find the maximum safe stress and the corresponding pay load. And also Shear stress analysis is performed for various parametric combinations to find the deformations and mode shapes to find the behavior of the die. And these deformations are compared with the excitation normal theoretical deformations at different loads on die at various materials applying.

Static Analysis

Static analysis is performed to find the Von Mises stress by using Ansys software and these results are compared with bending stresses calculated in mathematical analysis at various loads.
The following table gives bending stresses at various loads.

Table 1: Comparison of Theoretical stress and ANSYS Von–misses Stress

Materials	With material	Removing non stressing material
EN38	1617.8	1640.1
MILD STEEL	1595.9	1618.3
OHNS	1384.7	1405.3

It is seen that from the above graph, when load is increased the bending stress increases, linearly, so load-stress graph gives the straight – line relationship. The theoretical results and ANSYS results are varying in parallel as load increases. But in the case of first analysis had marginal increase in stress while the removing non-stressing material comparatively higher increases in stress values. For

© 2016 IJETCR. All Rights Reserved.

the EN38 die it is observed that at load 140TN, the stress crosses the yield stress (1479 N/mm^2) by considering the factor of safety 2. It is also observed that the stresses development in removing material condition configuration is much lesser than stresses observed in theoretical and die. Therefore it is concluded that the maximum safe payloads considered for analysis of removing material are safe for all the iterations

REFERENCES

1. Moser &Madl08/2009, Effective Run-In and Optimization of an Injection Molding Process
2. Kocjak, M.J., Kahtri,S.C., Allison, J.E and Jones, J.W. Fundamentals of Metal Matrix Composites (Eds S. Suresh, A. Mortensen and A. Needleman), 1993 (Butterworth-Heinemann, Boston).
3. Wu G.H., Dou Z. Y., Jiang L. T., Cao J. H., 2006, Damping properties of aluminium matrix – fly ash composites, *Materials Letters*, **60**: 2945-2948.
4. Davis Joseph R. ASM specialty hand book, aluminum and aluminum alloys. ASM International; 1993
5. Mondolfo L. F., "Design Aluminium alloys: Structure and properties", Butterworth and Co (Publishers) Ltd. London, (1976) 253.
6. Hassan, S. F., Gupta, M., Development of high strength magnesium copper based hybrid composites with enhanced tensile properties, Materials Science and Technology, 19 (2003) 253-259.
7. Ma, NG, Deng, CJ, Yu, P, Kwok, WY, Aravind, M, Ng, DHL, Chan, SLI, Formation of Mg-Mg_2Cu nanostructured eutectic in Mg-based metal matrix composite, Journal of Materials Research, 188. (2003)1934-1942.
8. Babu Rao J., Syed Kamaluddin, Appa Rao J., Sarcar M. M. M., Bhargava N.R.M.R., "Deformation behavior of Al–4Cu–2Mg alloy during cold upset forging", Journal of Alloys and Compounds, Vol. 471, 2009, pp. 128-136.
9. Babu Rao J, Venkata Rao D, Narasimha Murthy I., and Bhargava NRMR, "Mechanical properties and corrosion behaviour of fly ash particles reinforced AA 2024 composites", International Journal of Composite Materials (ISSN: 0021-9983)" – Vol.46(12), 2011, pp.1393-1404.
10. Kumar P.R.S., Kumaran, S., Srinivasa Rao, T., and Siva Prasad, K. , Microstructure and mechanical properties of fly ash particles reinforced AA6061 composites produced by press and extrusion, Transactions of the Indian Institute of Metals, 2009, 62, 559-566.

.

© 2016 IJETCR. All Rights Reserved.