IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 3, April 2025
Impact Factor: 7.67

Developing a Powder Feeding System for Tungsten Inert Gas (TIG) Cabling

Ajay Kumar Verma, MD Shahil Raza, Asraf Ansari, Kaushik Shekhar, MD Mustak Ansari, Manzar Hasan and Md Sarfaraj
Department of Mechanical Engineering
K.K. Polytechnic, Dhanbad, India

Abstract*: With the TIG cladding process, materials of diverse characteristics can be deposited or coated onto any structural element to improve its surface characteristics, including corrosion resistance, wear resistance, and hardness. Such materials can be deposited through a method utilizing powder blowing. A powder feeding system for the TIG cladding process has been designed and built in this research. The operation of several components has been explored. Furthermore, with a proper setup, this powder feed system can also be utilized within a general-purpose TIG welding system to make a low-budget cladding system.*

Keywords: TIG cladding process

I. INTRODUCTION

Tungsten Inert Gas (TIG) is a gas-shielded arc welding process involving a non-consumable tungsten electrode. The electrode is normally pure tungsten or tungsten thorium oxide or tungsten zirconium oxide alloys[1]. The shielding inert gas—typically argon or a mixture of argon and helium—is delivered through an annular gap encompassing the electrode to displace atmospheric gases in the region of the weld pool, thus safeguarding the weld pool. TIG welding is commonly employed for the joining of thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, and copper alloys because it can create strong, accurate, and clean welds. It is also being increasingly applied for the deposition of overlay materials to improve surface properties like hardness, corrosion resistance, and wear resistance, a process referred to as cladding[2]. Cladding is the process of placing an outer material on a foundation metal surface, usually performed by filler rods or powder[5]. Powder cladding is often performed through laser systems, but the TIG process offers a valid solution for this process as well. In contrast to filler rods, powder feeding is more controlled regarding material composition and mixing, making the surface properties more uniform. But powder feeding is even more prevalent in laser cladding because sophisticated and accurate feed systems are commercially available, which prove to be costly and difficult to align with the laser beam. In contrast, TIG cladding can take advantage of a less sophisticated and lower-cost powder feeding system that is made possible through existing TIG weld equipment[1]. The driving force behind this project is creating an economical and effective powder feeding system that is TIG welding compatible, allowing for cladding using different powder materials without the use of costly laser machines. The method has numerous benefits, such as low production time, fast cooling rates, local deposition, and being able to produce new alloy materials through adjusting powder mixes[8]. While some difficulty—e.g., maintaining adequate powder flow and managing penetration into the weld pool—can be experienced, a well-designed powder feeder system for TIG cladding can be highly beneficial in terms of increased versatility and accessibility of surface engineering operations[7].

DOI: 10.48175/IJARSCT-25072

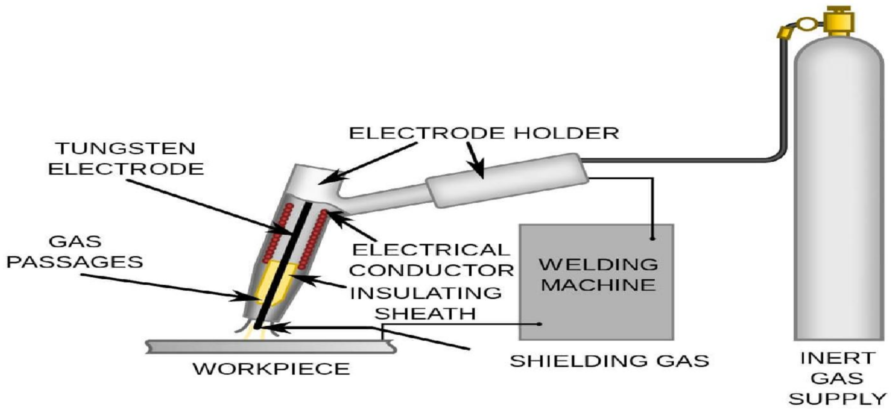

Fig:1.1 TIG Welding

II. EXPERIMENTAL DESIGN

In the workshop of the institution, a TIG powder feeding system for welding was built from the raw materials and acquired components required[6]. Before that, computer-aided design methods were employed to develop an in-depth design of the functional subsystems. SOLIDWORKS software, which is proficient in product design and analysis, was employed for this purpose[9]. The mixing chamber, nozzle holding structure, nozzle, powder container, vibrating unit, cam, and whole piping system are some of the components that were designed. In the production engineering laboratory, utmost care was taken to utilize the available space and materials to the maximum extent and also to make them convenient to use. Mild steel, pipes, some clamps, traditional nuts and bolts, and other items were employed to construct the end pieces in the workshop. Welding machines, grinding machines, drilling machines, round filling tools, and flat filling tools were used for fabrication. In order to enhance precision, a number of parts are procured from the commercial market.

- **Tractor:-** The welding torch is steadied and moved smoothly and accurately by the tractor, which serves as a foundation. It allows for precise travel along the weld line and can be manually or motor-adjusted. The consistent speed and direction of the tractor help ensure uniform cladding. It also provides structural support for the mounting of other components, including the nozzle holder[3].
- **Welding Torch :-**A critical element in the procedure of forming an arc between the tungsten electrode and substrate is the TIG welding torch. It possesses a cooling mechanism that employs either water or air and can be utilized manually or automatically. The torch in TIG cladding provides the heat source needed to melt the surface of the base material, thereby allowing the powder to weld onto the substrate.
- **Nozzle :-**The compressed air and powder flow is channeled to the welding torch through the nozzle. To avoid erosion due to high-speed powder particles, it is typically made of wear-resistant materials like sapphire or tungsten carbide[4]. The size and shape of the nozzle determine the precision and intensity of powder deposition on the workpiece.
- **Nozzle Holder :-**A structural component called the nozzle holder supports the nozzle at the right angle and position relative to the weld pool. It makes it easy to adjust and is usually bolted to the tractor. Powder is always and accurately supplied into the molten weld area by a properly positioned nozzle holder[6].
- **Flow-Rate Unit And Pressure Gauge :-**A pressure gauge and a filter-regulator-lubricator (FRL) set comprise this equipment. It filters out impurities, regulates compressed air pressure, and regulates the rate of powder flow[5]. For smooth powder flow and to avoid blockage or uneven deposition, the optimum pressure should be sustained.
- **Air Compressor:-**The pressurized air needed to transport powder particles from the mixing chamber to the nozzle is provided by the air compressor. For this purpose, a pressure of about 50 bar and a 3-horsepower,

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 3, April 2025
Impact Factor: 7.67

three-phase electric motor in the compressor are suitable. During the process of cladding, the compressor ensures a continuous and constant supply of carrier gas.

- **Mixing Chamber:-**Powder and compressed air are blended together in a sealed device referred to as the mixing chamber. Vibrating and turbulent flow are designed to promote uniform blending. Agglomeration of particles is prevented and a uniform powder stream is fed into the nozzle by good mixing[7].
- **Vibrating Assembly :-**In an effort to maintain the powder flowing, prevent settling, and promote smooth flow, this device causes the mixing chamber or powder vessel to vibrate. A cam is typically coupled with an induction motor[9]. The powder is constantly introduced into the air stream due to the vibration.
- **Piping System:-**Compressed air and the powder-air mixture are conveyed from the mixing chamber and compressor to the nozzle through flexible, durable pipes (like braided nylon hoses). Besides enabling smooth flow with minimal loss, the pipe system should be able to endure wear and maintain internal pressure[8].

III. WORKING METHODOLOGY

Powder materials:-

Metal powder is a powdered metal such as aluminium powder and iron powder. Carbide powder can be used for this purpose because it is very light and easily available

Bit size average (nm)	Allowed changes (nm)	Special surface area g	Volume density (g/cm3)
80	≥60~100	> 8	0.06~0.8

The powder was stored in this way in a container which was well cleaned, airtight, and polished[12]. Then the compressor pipe was joined to its inlet end, and it was well tightened. Then the pipe by which powder was conveyed was joined to the outlet end and air and powder mixed. That vessel is the mixing chamber of air and powder. An induction motor was joined to that vessel by a cam joint. The other end of the outlet pipe was properly fixed on to the steel pipe. A centre lathe threaded the other end of that steel pipe. The thread portion was subsequently fitted with a tungsten carbide nozzle in a secure manner and bolted. The part about gripping the nozzle was already described[11].
Air flows into the mixing chamber as soon as the compressor is plugged in and turned on. When the motor is powered in and started, the cam motion makes the mixing chamber vibrate, shaking up the powder within. The air and powder will properly blend because of the vibration, and the mixture will be expelled from the chamber through the exit pipe to the nozzle tip because of high pressure. Gas agglomeration will be reduced as air is used as a carrier gas[10].

Fig:1.2Experimental Setup of TIG Welding

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 3, April 2025
Impact Factor: 7.67

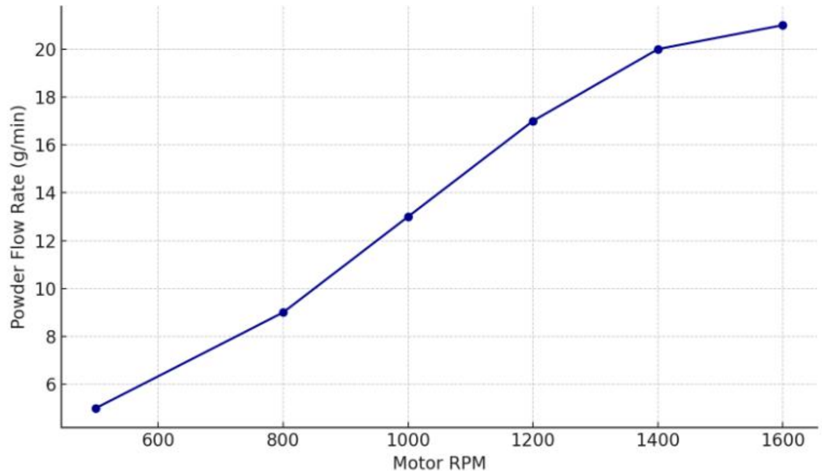

Fig:1.3 Relationship between **Motor RPM** and **Powder Flow Rate**

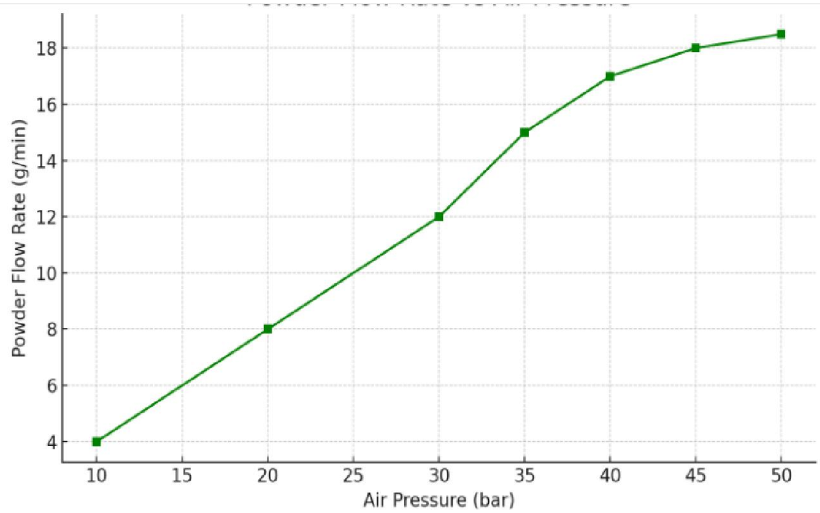

Fig:1.4 Relationship between **Powder Flow Rate vs Air Pressure**

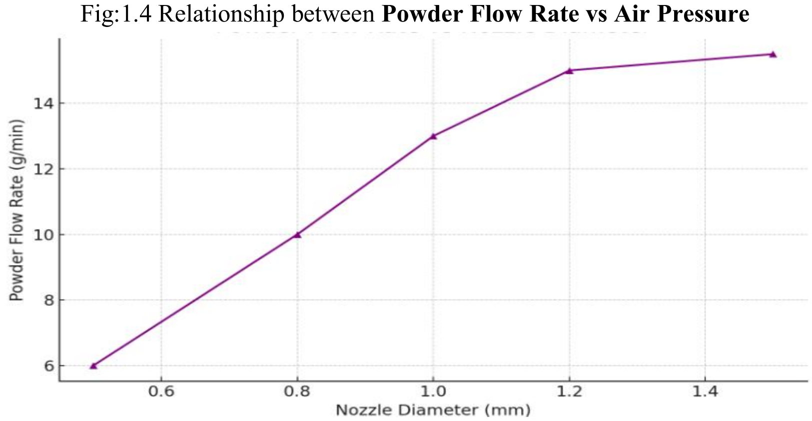

Fig:1.5 Relationship between Powder Flow Rate vs Nozzle Diameter

IV. RESULT

A TIG cladding arrangement was developed and tested to make sure that the powder flowed. A test was made to make sure that the air and powder material were well incorporated. The functionality of different components was checked. In order to test abrasive particles, they were placed initially in the mixing chamber. More powder materials can be explored depending on availability. The outcome will be improved using low density powder, e.g. carbides or aluminium. The speed of the motor can be controlled to regulate the rate of flow.

V. CONCLUSION

The design and development of a powder feeding system for TIG cladding have been successfully achieved using cost-effective and easily accessible components. In contrast to laser cladding, which requires high-cost and sophisticated setups, this TIG-based system offers a less complex alternative for surface modification through powder deposition. By proper integration of a mixing chamber, vibrating assembly, flow control mechanisms, and a precision nozzle arrangement, the system was able to attain secure and consistent powder flow into the weld pool. Experimentation using various types of powders was conducted, and the results validated the satisfactory operation of all subsystems, such as controlled mixing and delivery of powder via compressed air. Light powders like aluminum and carbides had improved flow behavior, and cladding quality depended on parameters such as air pressure, motor speed, and nozzle configuration.This paper proves that powder-fed TIG cladding can be an efficient alternative to laser cladding, especially in research institutions and small industries where costs are an issue. The performance of the system suggests that additional improvements—like torch movement automation, employment of high-tech materials for nozzles, and advanced powder-mixing technologies—would enhance deposition accuracy and reproducibility considerably. Successful operation of this setup creates new opportunities for performing advanced cladding experiments and facilitates future studies in material surface engineering on TIG welding platforms.

REFERENCES

[1] X.-L. Gao et al., "A comparative study of pulsed Nd: YAG laser welding and TIG welding of thin Ti6Al4V titanium alloy plate," *Engineering Materials*, vol. EM15-2012-029, Switzerland, 2013.

[2] T. Torims, "The application of laser cladding to mechanical component repair, renovation and regeneration," in *DAAAM International Scientific Book*, B. Katalinic and Z. Tekic, Eds., Vienna, Austria: DAAAM International, 2013, ch. 32, pp. 587–608, ISBN 978-3-901509-94-0.

[3] F. Meriaudeau, F. Truchetet, D. Grevey, and A. B. Vannes, "Laser cladding process and image processing," *Journal of Lasers in Engineering*, vol. 6, pp. 161–187, 1997.

[4] H. Gedda, *Laser Cladding: An Experimental and Theoretical Investigation*, Luleå University of Technology, Sweden, 2004, ISSN: 1402-1544, ISRN: LTU-DT--04/41--SE.

[5] L. Chen et al., "Study on effect factors and control process of match between cladding powder and laser beam in co-axial powder feeding laser cladding," *Advanced Materials Research*, vol. 184–185, pp. 1438–1441, 2012.

[6] I. Tabernero et al., "Energy attenuation modelling for laser cladding process with co-axial powder nozzles," presented at the *16th International Symposium on Electromachining (ISEM)*, Shanghai, China, 2010.

[7] F. Meriaudeau et al., "Machine vision system applied to the characterization of a powder stream: Application to the laser cladding process," in *Proc. SPIE-Int. Soc. Opt. Eng.*, vol. 3309, pp. 22–31, 1998.

[8] Yu. V. Kontsevoi, "Vibro-erratic mixing of the powders in a gas medium: Computing kinematics of a valve and powder and determining optimum sizes of mixing elements," *Journal of Applied Chemistry*, vol. 50, pp. 507–512, 2009.

[9] X. Hu, "Design of lateral powder nozzle for broad beam laser cladding," *Light Industry Machinery*, vol. 32, pp. 10–12, 2014.

[10] H. Kayser, "Thermal spraying under argon atmosphere," *Thin Solid Films*, vol. 39, pp. 243–250, 1976.

[11] M. Celant and L. M. Smith, *CASTI Handbook of Cladding Technology*, 2nd ed., American Society for Metals, Jan. 2010.

[12] *Welding Handbook*, Part-1, Miami, FL: American Welding Society, 2004.