Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 04, April -2018

EASILY ACCESSIBLE IMPLANTABLE PORT USING FERROFLUID

M.R.Jani

Associate Professor, Instrumentation and Control Engineering, Shantilal Shah Engineering College, Sidsar Campus, P.O.Vartej, Bhavnagar, Gujarat, India

Abstract- *Implantable port is very important to the patients undergoing frequent IV infusion. To locate the port and insert the needle is a very crucial task. The ferrofluid has some unique characteristics which can be used to make the port very friendly to nursing staff and the patient. The magnetic fluid and the implantable port are from totally different field. In this paper an effort is made to show an application of both together. The paper explains how it can be achieved by simulating the actual setup with available material.*

Keywords- *Implantable port, ferrofluid, infusion needle, magnet.*

I. INTRODUCTION

A magnetic fluid is a magnetic colloid sometimes called as a ferrofluid. Ferrofluids are a special category of smart nanomaterials, in particular magnetically controllable nanofluids[1]. These types of nanofluids are colloids of magnetic nanoparticles (figure 1), such as Fe3O4, γ-Fe2O3, CoFe2O4, Co, Fe or Fe-C, stably dispersed in a carrier liquid [2].

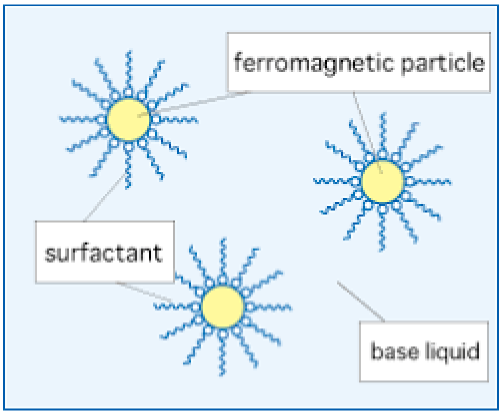

Figure 1 ferrofluid composition

Macroscopically, the introduction of magnetic forces into the fundamental hydrodynamic equations for the quasihomogeneous magnetizable liquid medium gives rise to the magnetohydrodynamics of magnetic nanofluids (ferrofluids), known also as ferrohydrodynamics and opens up an entire field of new phenomena [3] and promising applications [4]. From a microscopic point of view, long-range, attractive van der Waals and magnetic forces are ubiquitous and therefore must be balanced by Coulombic, steric or other interactions to control the colloidal stability of dispersed nanoparticle system, even in intense and strongly non-uniform magnetic field, specific to most of the applications [5, 6]. Figure 2 show the orientation of particles.

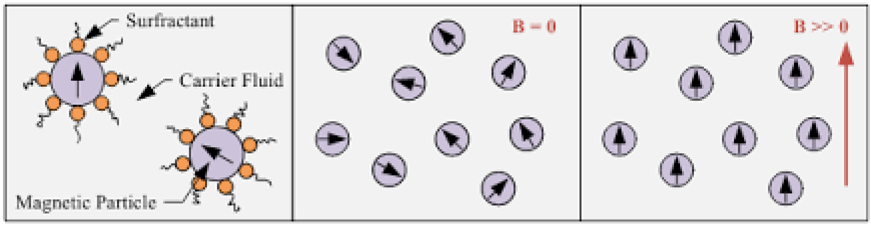

Figure 2 Behavior of Ferrofluid particles with and without magnetic field

Applications of these material (fluid) is still increasing in numbers as well as in different fields since their inception. Ferrofluids are different from the usual magnetorheological fluids which are used for dampers, brakes and clutches, formed by micron sized particles dispersed in oil. In magnetorheological fluids when a magnetic field is applied, viscosity increases enormously. Due to this for strong enough fields, they may behave like a solid. While a ferrofluid keeps its fluidity even if subjected to strong magnetic fields.

Over the last few decades, many management changes have occurred in oncology settings, particularly with respect to new chemotherapy combinations. Implantable port systems (figure 3) which resolve the problem of vascular access [7] have become an essential prerequisite for many chemotherapy protocols for solid tumors and hematological malignancies and are extensively used world-wide [8].

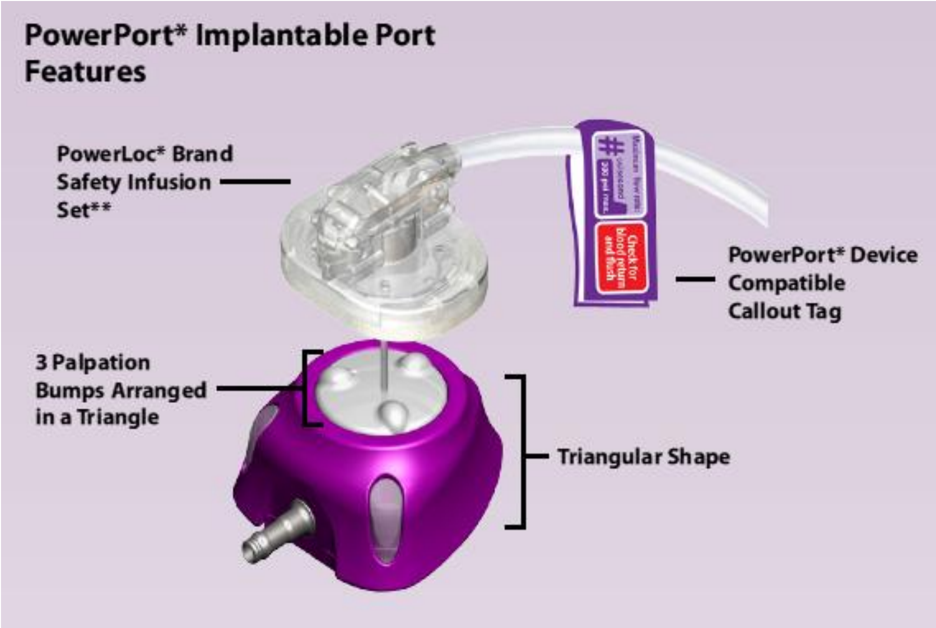

Figure 3 Implantable port courtesy [20]

Implantable ports which were first introduced in 1982 by Niederhuber are currently implanted with a high success rate and are routinely used in oncology, facilitating long-term chemotherapy and other procedures [9]. They have definitely changed the quality of life among cancer patients [10]. These ports are used for safe administration of chemotherapy, antibiotics, parenteral nutrition, and frequent draw of blood for laboratory tests, transfusion of blood and blood products and contrast media injection [11-16]. These ports can be placed in chest, forearm or upper arm [10]. Figure 4 shows some arrangements.

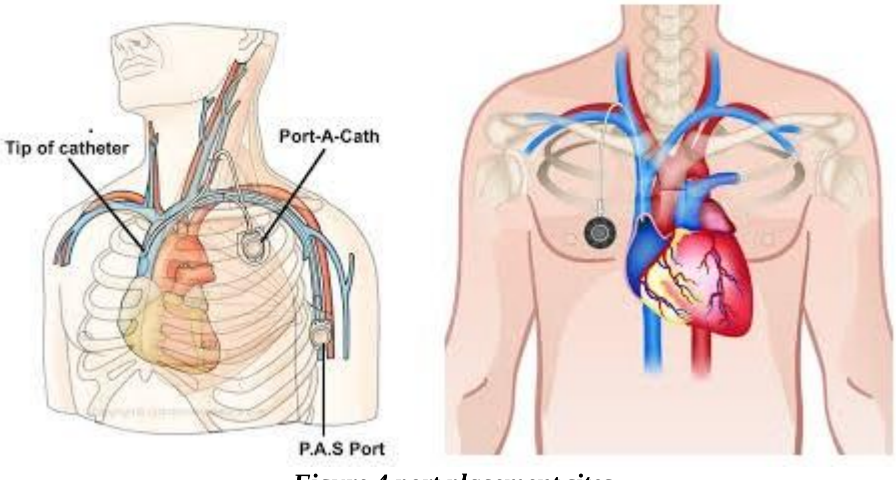

Figure 4 port placement sites

Implantable port systems have some merits and disadvantages. Merits of using these kind of ports are being a more acceptable cosmetic option; allowing better bathing, swimming and playing [13], no need for external dressing; possibility of patient mobility and most importantly probably being less prone to infectious complications and minimizing the occlusion rate of the catheter compared to non totally implantable catheters [9]. They may be accepted to patients concerned about the presence of the visible external part of non-implanted catheters. On the other hand implantable ports are more expensive to purchase; difficult to insert and remove; and also leave larger scars [16]. Patient's selection is an important criterion for placing a port. Malnourished patients are best to be avoided since the tissue will not hold the port and the skin over the port may get necrotic[18].

II. THEORY

As the port is implanted beneath the skin, it is not visible as well as it might be difficult to locate. At the time of the infusion the port is to be accessed by means of the chemo needle or the port infusion set figure 5.

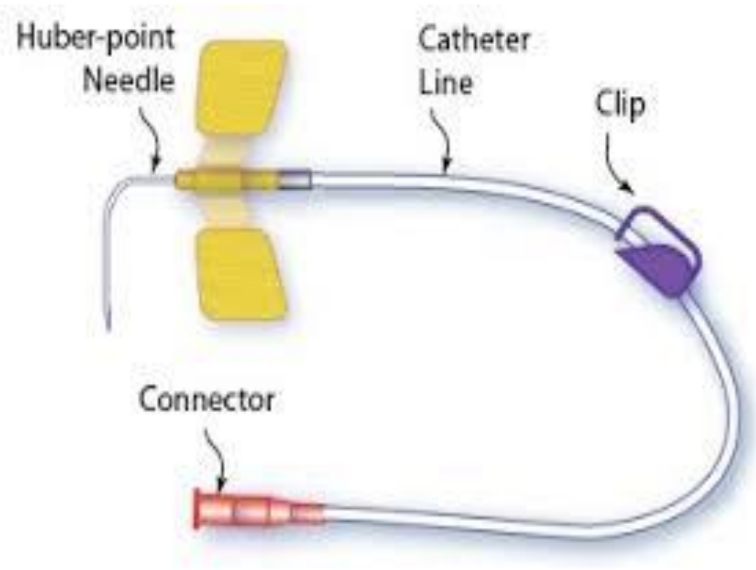

Figure 5 Needle and accessories

To place the needle in the port is very delicate task as shown in figure 6 as the port in beneath the skin. At the same time it may be painful to the patient if multiple punctures are required due to misplaced insertion. This may be very risky as the chances of infection are highest at the time of needle insertion.

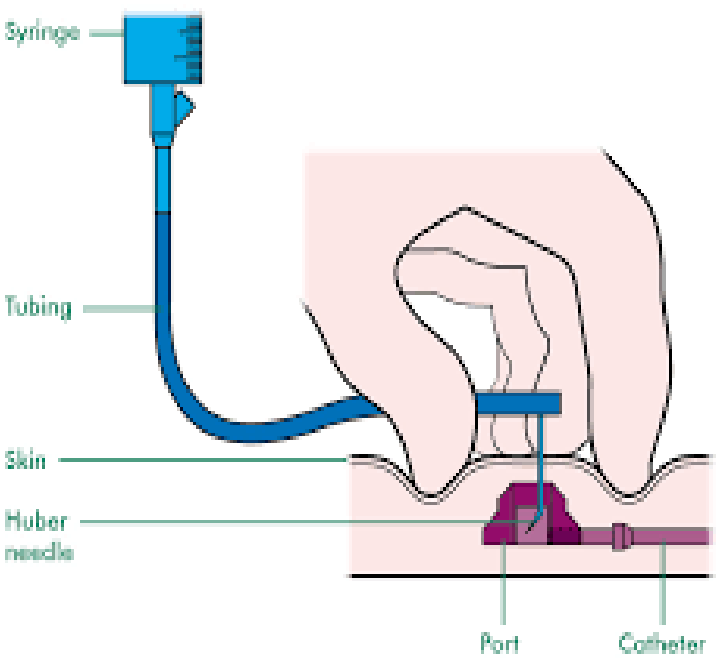

Figure 6 Inserting needle in the port

In case of multiple failure of the needle insertion, sometimes ultra sonic imaging or even X-ray imaging is required to be used. Figure 7 shows the images of ultra sound and X-ray images. This is not easy and very expensive as the ultra sound or X-ray imaging machines are not very common and expensive. The patient is to be taken to the location where these machines are available. It may cause problems to the patient as well as the nursing staff.

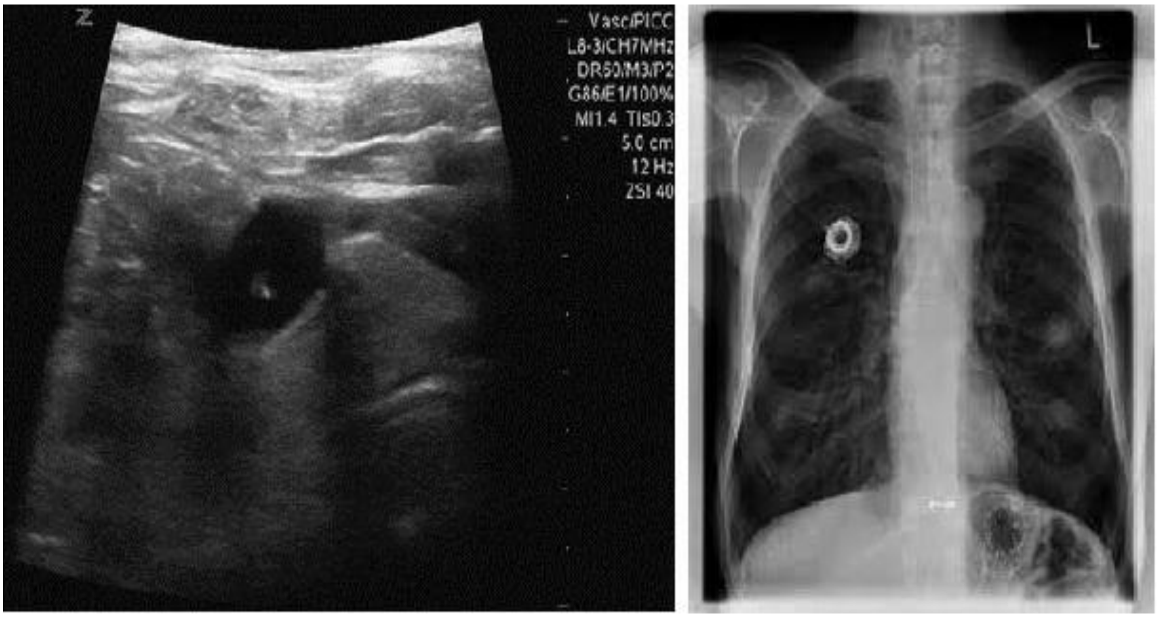

Figure 7 a. Ultrasound image b. X-ray image

Ferrofluid can be a solution to the problem. Property and Application of ferrofluid can help to achieve the task. The ferrofluid exhibits the magnetic behavior in presence of the magnetic field. A major benefit of ferrofluid is that the liquid can be forced to flow via the positioning and strength of the magnetic field and so the ferrofluid can be positioned very exactly.[19]

When the ferrofluid is magnetized by the permanent magnet it behaves like a liquid ferro material. It gets attracted towards the magnet and it prevents the container to change its position.

1. III. EXPERIMENTAL SETUP

A provision to fill the ferrofluid is made. Inside the enclosure, a hollow ring filled with ferrofluid is placed. Figure 8 shows the ring. The ferrofluid is filled in the ring.

Figure 8 The ring field with Ferrofluid

The experimental set up is shown in the figure 9. The implantable port is replaced by similar size of package enclosure of a buzzer. The skin is replaced by the card board as the impedance and permeability of card board is higher than that of the skin. The package has almost same physical properties. It is clear that the arrangement work exactly as per the requirement.

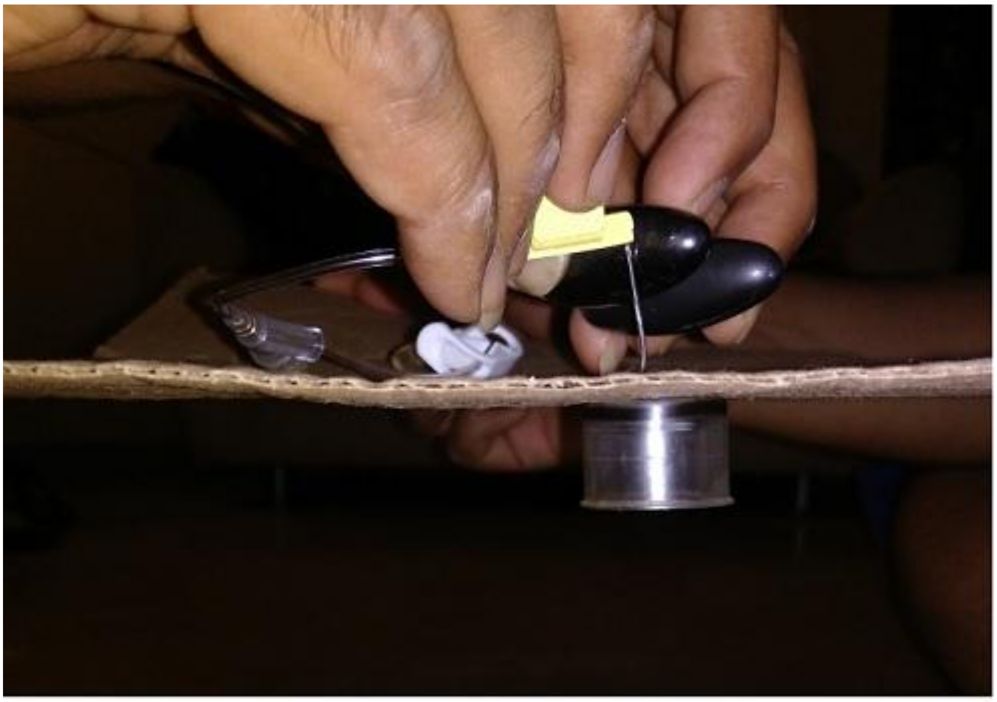

Figure 9 Experimental Setup showing perfect insertion of needle in the port

During the normal circumstances, the port (enclosure) does not need to be cared as it is beneath the skin. When the port (enclosure) is required to be accessed, a strong magnet is used and placed above the tentative location of the port (enclosure). The strong magnetic field of the large magnet attracts the ferrofluid placed inside the ring. Due to this phenomenon the port (enclosure) position can be fixed, and the needle or the infusion set can be easily inserted in the port.

IV. CONCLUSION

The setup shows excellent results. The port (enclosure) is located and the needle placed in the port with out any difficulty. Cost to success ratio is excellent as at very low cost and efficiently the task is achieved.

REFERENCES

[1] S. Odenbach (Editor), Ferrofluids: Magnetically controllable fluids and their applications, Lecture Notes in Physics, Springer-Verlag, 253 pags (2002).
[2] S. W. Charles, The preparation of magnetic fluids, in: S. Odenbach (Editor), Ferrofluids: Magnetically controllable fluids and their applications, Lecture Notes in Physics, Springer-Verlag, pp.3-18, 2002. See also: S. W. CHARLES, Preparation and magnetic properties of magnetic fluids, Rom. Repts. Phys., vol.47 (3-5), pp.249-264, 1995.
[3] R.E. ROSENSWEIG, Ferrohydrodynamics, Cambridge Univ. Press, pp.344, 1985; see also J.L. Neuringer, R.E. Rosensweig, Phys. Fluids 7(1964)1927
[4] B. Berkovsky, V. Bashtovoi (Eds.), Magnetic fluids and applications handbook, Begell House, NewYork, pp.831, 1996.
[5] L. Vekas, D. Bica, M. V. Avdeev, Magnetic nanoparticles and concentrated magnetic nanofluids: synthesis, properties and some applications, China Particuology, 2007 (to appear); see also: I. Anton, I. De sabata, L. Vekas, Application orientated researches on magnetic fluids, J. Magn. Magn. Mater.,mvol.85, pp.219-226, 1990.
[6] K. RAJ, Magnetic fluids and devices: a commercial survey, in: B. Berkovsky, V. Bashtovoi (Eds.), Magnetic fluids and applications handbook, Begell House, New York, pp.657-751 (1996)
[7] Vescia1 S, Baumga A, Jacobs VR, Kiechle- Bahat M, Rody A, Loibl1 S, Harbeck N. Management of venous port systems in oncology: A review of current evidence. Annals of Oncology. 2008; 19(1):9-15.
[8] Bassi KK, Giri AK, Pattanayak M, Abraham SW, Pandey KK. Totally implantable venous access ports: Retrospective review of long-term complications in 81 patients. Indian J Cancer. 2012;49(1):114-8.
[9] Plumhansa C, Mahnkena AH, Ocklenburgb C, Sebastian Keil S, Behrendta FF, Günthera RW, Schotha F. Jugular versus subclavian totally implantable access ports: Catheter position, complications and intrainterventional pain perception. European Journal of Radiology. 2011;(79) 338-42.
[10] Di Carlo I, Pulvirenti E, Mannino M, Toro A. Increased Use of Percutaneous Technique for Totally Implantable. Venous Access Devices. Is It Real Progress? A27-Year Comprehensive Review on Early Complications. Ann Surg Oncol. 2010; 17(6):1649-56.

[11] Goltz JP, Petritsch B, Thurner A, Hahn D, Kickuth R. Complications after percutaneous placement of totally implantable venous access ports in the forearm. Clinical Radiology 2012;67(11):1101-7.
[12] Nagel SN, Teichgräber UK, Kausche S, Lehmann A. Satisfaction and quality of life: A survey-based assessment in patients with a totally implantable venous port system. European Journal of Cancer Care. 2012;21(2):197-204.
[13] Rouzrokh M, Shamsian BS, KhaleghNejad Tabari A, Mahmoodi M, Kouranlo J, Manafzadeh G, et al. Totally Implantable Subpectoral vs. Subcutaneous Port Systems in Children with Malignant Diseases Archives of Iranian Medicine,2009; 12(4):389-94.
[14] Pasha F, Mahajan A, Kaul S, Nayyar RV. Implantable ports in pediatric oncology patients. Apollo Medicine. 2004(1):105-
[15] Viale, PH. Complications Associated With Implantable Vascular Access Devices in the Patient with Cancer. Journal of Infusion Nursing. 2003;26(2):97-102.
[16] Bishop L, Dougherty L, Bodenham A, Mansi J, Crowe P, Kibbler C, et al. Guidelines on the insertion and management of central venous access devices in adults. International Journal of Laboratory Haematology. 2007;29(4):261-78.
[17] Gallieni M, Pittiruti M, Biffi R. Vascular Access in Oncology Patients. Cancer J Clin. 2008; 58(6):323-46.
[18] How to Care for Implanted Ports https://www.researchgate.net/publication/269092548 May 2013
Nourbakhsh MK 1, Nekoee A 2*, Nemati SH 3, Gheibizadeh M 4
[19] https://www.azom.com/article.aspx?ArticleID=6726
[20] https://www.bardaccess.com/products/ports

