

Universidad de Montemorelos
Facultad de Ingeniería y Tecnología

**Desarrollo de Prototipo de Generación de Presión Subatmosférica
Para Estudio del Tratamiento de Presión Negativa en
Heridas Crónicas a Nivel Laboratorio**

Informe de Investigación
presentada en cumplimiento parcial
de los requisitos para el grado de
Licenciatura en Ingeniería Industrial y de Sistemas

Por

Edison Jessie Vázquez Gordillo

Abril de 2015

DECLARACIÓN DE INTEGRACIÓN DE LA FE

Creo que la humanidad llegó a existir por la creación directa de Dios (Génesis 1:26-27). Creo que Dios nos dio el privilegio de ser mayordomos del planeta tierra (Génesis 1:28) y también de cuidar y amar a nuestro prójimo (Mateo 22:39). Por lo tanto dentro de las muchas aflicciones que atormenta al ser humano tales como las enfermedades crónicas, queremos ser de ayuda y aportar avances para el tratamiento de estas, aprovechando nuestros talentos que Dios nos ha otorgado para el beneficio de los demás.

HOJA DE APROBACIÓN

DESARROLLO DE PROTOTIPO DE GENERACIÓN DE VACÍO PARA
TRATAMIENTO DE PRESIÓN NEGATIVA EN HERIDAS
CRÓNICAS A NIVEL LABORATORIO

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Prototype Development Generating Vacuum for Treating Chronic Wounds Negative Pressure Level Laboratory

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Abstract— at present the medical care is being referred not only to the presentation of the disease itself but their complications and variations that day will be chronic and therefore more devastating. With the known increase in overall life expectancy, we know that we face a different type of disease. A case of these chronic wounds; which is a condition that has generated a very high cost both in financial perspective, and complications such diseases generate. Negative pressure therapy is a procedure that has caught the attention of health professionals due to its effectiveness. But for many of them remains unknown biochemical process behind this therapy. On the other hand, is a process becomes costing up to \$ 40,000. As only a small percentage of the population could afford to use a system of this type may help treat a condition of chronic wound. For this project a methodology that involves the development of a prototype Generation Vacuum Negative Pressure Treatment in Chronic Wounds Level Laboratory is proposed. The scope of this paper to analyze the variables involved in the negative pressure system in order to generate models of fluids and colloids for the study of the variables that are in the process of healing of chronic wounds. With this support to glimpse a niche research and development in the area of devices negative pressure therapy inexpensive that expand the range of use and range of users.

Keywords—Chronic wounds, subatmospheric pressure, negative pressure, wound

I. INTRODUCTION

At present, due to increased life expectancy, people live longer and more complex diseases have increased surgical treatments, especially of chronic wounds and complications. [1]

Chronic wounds are a major problem for patients, physicians and health systems, a study showed that these have affected 5.7 million people in the United States, investment an estimated 20 billion dollars annually in treatment. The state health systems are obliged to provide services to the entire population, but there is a noticeable trend. [2] Treatment of chronic wounds is a huge burden on health systems. One study estimated that the cost of injuries to the NHS in the UK, is around £ 1 billion a year. [3] In this country, there are about 24,000 hospital admissions per year, which are for patients with diabetic foot ulcers, costing approximately £ 17millones. [4] Foot ulceration is the most common complication of diabetes that requires hospitalization; where the management of this problem US is estimated to cost \$ 150 million a year. [5] Venous leg

ulceration has an estimated cost of £ 400 million a year in the UK. [6] Most of this cost ointments and visiting nurses should. The cost of treating pressure ulcers, some of which could have prevented was estimated at 300 million pounds for more than 10 years. [7] These sums show only the direct costs, but do not reflect the frustration, economic loss and impaired quality of life of patients with ulcers and chronic wounds.

One of the many complications of chronic wounds is that they can develop the environment for many other diseases and are the source of considerable morbidity and health care costs. These wounds require aggressive multifactorial approach including surgical debridement, revascularization, antibiotics and bandages. [8] There are currently three types of approach wounds: Traditional or dry cure, Traditional or dry cure that makes use of dressings or bandages passively only covers the wound and has no interaction with it. The advanced, or in wet, cure is one that is done with bandages or gauze soaked in saline trying to maintain a moist wound environment. Advanced techniques in wound healing require advanced technology. Among them we hyperbaric oxygen therapy and wound healing with topical negative pressure. [9] Therapy negative pressure wound has become increasingly important in the treatment of the same part. [10] Currently, this process is presented as an alternative method and accessible in any hospital environment. Mechanical treatment is used as an adjunct in wound healing; can be applied continuously or intermittently for both acute and chronic wounds. [11] It is an alternative to traditional methods of healing, being fast, effective and easy to use. [12] An analysis on wounds with an average diameter of 22.2 cm², treated by traditional techniques, it would take about 247 days to heal at a cost of \$ 23,465USD. While therapy with negative pressure wound, a similar wound would heal in 97 days and cost from \$ 14.546 US dollars. [13] The study concluded that therapy negative pressure wound is a form of effective and economical treatment for a variety of chronic wounds. However, cost healing \$ 14, 546 USD as reported by Philbeck remains a problem for a lot of people in the world.

In this situation it is proposed to build a prototype for generating negative pressure parameters controllable and measurable pressure to analyze the variables involved in the processes of negative pressure therapy of chronic wounds. Similarly generate colloids fluid models and design and

develop an experiment to analyze the variables in the healing process by negative pressure therapy.

II. MATERIALS AND METHODS

For the development of this project an exploration of literature based on negative pressure in order to increase knowledge about the different types of wounds, healing methods and their classification was performed. Likewise a literature review was performed with respect to different vacuum pump technologies to observe the mechanical components of this. Finally, considering the results of the previous stage, we worked on the design and construction of prototype vacuum pump (Fig. 1) which is composed of an alternate engine Matsushita Electric UDS1401SM current 500W able to exert a negative pressure less than the 5mmHg inside a drain pan with 1 liter. This pressure is regulated by an industrial DIMMER and monitored by a vacuum gauge 30 mmHg RITER; these components are structured through copper pipes from other welding materials.

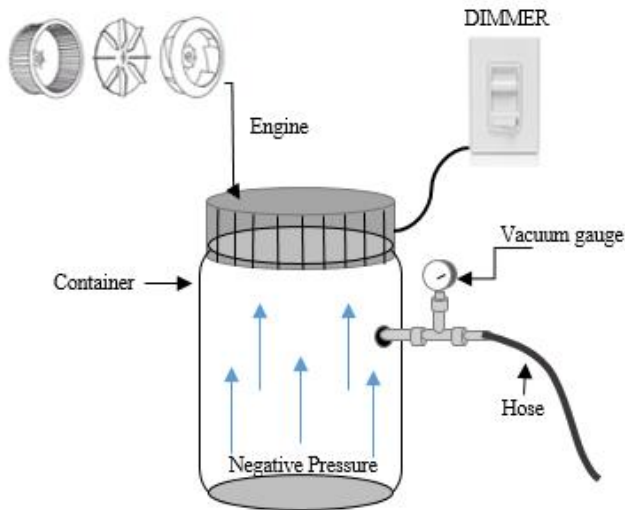


Fig. 1 Vacuum pump device

By having the prototype of negative pressure proceeded to design and develop protocols artificial substitutes' in vitro tissue in order to understand in detail the behavior of our device and suction capacity across samples with high percentages of viscosity. An experiment with samples consisting entirely of water and gelatin rates was performed. 40 trials were generated in blocks of 4 with different amounts of gelatin and a standard amount of water (Table 1).

Table 1. Volume of water and gelatin mass

Volume of water	Gelatin mass
500 ml.	0 g.
500 ml.	7 g.
500 ml.	14 g.
500 ml.	21 g.

The procedure of this experiment involves several stages. First mathematical calculations were performed to obtain the densities of these compounds. After hypotheses were developed, was taken as the response variable (y) the suction time and as a dependent variable (x) the density levels of the compounds.

y= Suction time

x= Density levels: 1 gr/ml, 1.014 gr/ml, 1.028 gr/ml y 1.042 gr/ml

ANOVA single factor was applied. When considering the design of the experiment was continued with the mechanical part. The samples were placed in a glass with capacity of 700 g. The device started to suck out the first sample of the first block in order as shown in Table 1. Each time a sample was conducted was the substance to be sucked back to the vessel to repeat the process which is generated ten times per block. The suction time was taken with an industrial timer.

The data were put into a database for later analysis. Statistical analysis was performed using Minitab 15.

III. RESULTS

No significant violation of the assumptions of the model residuals was found. ANOVA model fit was 26.21%. Outliers one observed in the number 10 shows the level 1028 at the value of that sample was ignored.

Statistical evidence (Fig. 2) that there is significant difference between the mean densities (P = 0.013) was found.

ANOVA unidireccional: Time (sec) vs. Density (gr/ml)

Fuente	GL	SC	MC	F	P
Density (gr/ml)	3	43.65	14.55	4.14	0.013
Error	35	122.87	3.51		
Total	38	166.52			

S = 1.874 R-cuad. = 26.21% R-cuad. (ajustado) = 19.89%

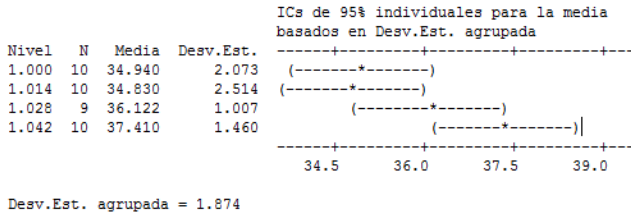


Fig. 2 Table ANOVA

Figure 3 shows a box plot of time which reflects check the evidence that there is significant difference between the different densities with respect to time shown suction.

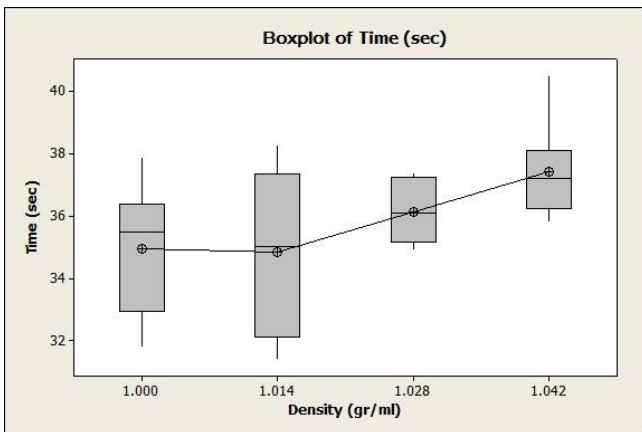


Fig. 3 Box plot of Time sec.

IV. DISCUSSION

It was observed that the device is working properly at the time of sucking substances, although the suction time increases when the substance is denser complications does not imply the contrary helps to consider the ability of our device.

The experiment that the performance of our device was developed at laboratory valid with respect to the suction process of dense samples.

V. CONCLUSIONS AND FUTURE WORK

The results obtained up to this stage build a precedent for prototyping negative pressure having both an application in the area of development of negative pressure systems, as well as develop teaching prototypes to analyze in more detail the operation of this device.

With the completion of this project to validate original devices promote healing processes human tissues experimental protocols were created.

The results for the design of new experiments are taken into account. A subsequent study that considered most compounds and densities to validate the finding found and other physical to understand more deeply the process that occurs within the vacuum system variables are completed.

VI. ACKNOWLEDGMENTS

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