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Design and development, of refrigerant recovery system- trainer in Autotronics technology

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Abstract
This research addresses the critical need for practical training in refrigerant recovery within autotronics education. The study focuses on the design and development of a refrigerant recovery system integrated with an air conditioning trainer for use in the Autotronics laboratory at the University of Science and Technology of the Philippines. The absence of such a system has hindered students' ability to gain hands-on experience with refrigerant recovery, a crucial skill for the automotive industry. This project aims to develop a system that provides practical training and addresses safety, environmental, and educational concerns associated with traditional refrigerant handling methods. The research objectives include designing and developing a functional prototype and evaluating its performance against educational and basic industry standards. The anticipated outcome is a fully functional, efficient, and instructional refrigerant recovery system that enhances student learning outcomes in autotronics technology and promotes environmental sustainability.

Keywords: Refrigerant recovery system, autotronics, air conditioning trainer, automotive education, practical training, system design, environmental sustainability.

Introduction

In recent years, the global automotive industry has undergone a significant transformation, driven by the growing emphasis on sustainability and environmental responsibility [1]. One critical aspect of this shift is the proper handling and recovery of refrigerants used in vehicle air conditioning systems. As the world becomes increasingly aware of the environmental impact of greenhouse gas emissions, the need for effective refrigerant recovery has become a pressing concern [2].

Globally, the automotive industry has been at the forefront of efforts to address the environmental challenges posed by refrigerants. Governments and regulatory bodies worldwide have implemented stricter policies and regulations aimed at reducing the release of harmful refrigerants into the atmosphere. The Montreal Protocol, an international agreement signed in 1987, has been instrumental in phasing out the use of ozone-depleting substances, such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which were commonly used as refrigerants in the past [3]. The subsequent introduction of more environmentally friendly alternatives, such as hydrofluorocarbons (HFCs) and hydrofluoroolefins (HFOs), has further highlighted the importance of proper refrigerant management.

In addition to regulatory pressures, the automotive industry has also faced growing consumer demand for environmentally conscious products and services. Consumers are increasingly aware of the environmental impact of their choices and are seeking vehicles and automotive services that prioritize sustainability [4]. This shift in consumer preferences has prompted automotive manufacturers and service providers to invest in technologies and processes that minimize the environmental footprint of their operations, including the proper handling and recovery of refrigerants.

At USTP-CDO, the Department of Autotronics at the College of Technology has recognized the importance of equipping students with the necessary skills and knowledge to address the challenges associated with refrigerant recovery in the automotive industry. As a leading provider of automotive education, the department has a responsibility to ensure that its graduates are well-prepared to meet the industry's evolving demands.

The current state of the autotronics laboratory, however, presents a significant challenge. The lack of integrated refrigerant recovery systems in the laboratory has resulted in a gap in the practical training of students. Without access to such systems, students are missing out on the crucial hands-on experience required for the proper handling and recovery of refrigerants, a critical skill in the automotive air conditioning field.

The automotive industry in the country has been undergoing a period of rapid growth and transformation, driven by the increasing demand for personal transportation and the need to address environmental concerns [5]. The government has implemented various policies and initiatives to support the industry's transition towards more sustainable practices, including the promotion of electric vehicles and the enforcement of stricter emissions standards.

Despite these efforts, the proper handling and recovery of refrigerants in the automotive sector remain a significant challenge [6]. Many service providers and workshops continue to struggle with the proper disposal of refrigerants, often resorting to improper methods that can have detrimental effects on the environment. This issue is further compounded by the limited availability of specialized training and equipment, particularly in the educational institutions that serve as the primary pipeline for the industry's future workforce.

The current lack of integrated refrigerant recovery systems in the Autotronics laboratory at the College of Technology has resulted in a significant gap in the practical training of students. Without access to such systems, students are missing out on the crucial hands-on experience required for the proper handling and recovery of refrigerants, a critical skill in the automotive air conditioning field [7]. This research problem has persisted for several years, hindering the department's ability to provide comprehensive and industry-relevant education to its students.

The focal point of this research is to address this problem by designing and developing a refrigerant recovery system that can be integrated into the existing air conditioning trainers in the Autotronics laboratory. This system will enable students to gain practical experience in refrigerant recovery, equipping them with the necessary skills to meet the industry's evolving demands and contribute to environmental sustainability.

The problem of the lack of integrated refrigerant recovery systems in the Autotronics laboratory has persisted for several years, with significant implications for both the students and the environment [8]. Firstly, the absence of this critical training component has hindered the department's ability to provide comprehensive and industry-relevant education to its students. As the automotive industry continues to emphasize the importance of sustainable practices, the demand for skilled technicians who can properly handle and recover refrigerants has only increased [1]. By failing to address this issue, the department risks producing ill-equipped graduates to meet the industry's needs, potentially limiting their employability and competitiveness in the job market.

Secondly, the improper disposal of refrigerants can have severe environmental consequences. Refrigerants, such as HFCs and HCFCs, are potent greenhouse gases that can contribute to global warming and ozone depletion if released into the atmosphere. The lack of proper training and equipment in the Autotronics laboratory increases the risk of these harmful substances being mishandled or improperly disposed of, with far-reaching implications for the environment [8]. If the problem remains unresolved, the consequences can be severe. Students will continue to lack the necessary practical skills and knowledge to address the critical issue of refrigerant handling, limiting their ability to meet the industry's demands and potentially contributing to the improper disposal of these harmful substances. This, in turn, can have significant environmental and economic consequences, as the release of refrigerants can lead to increased greenhouse gas emissions, ozone depletion, and the need for costly remediation efforts.

The importance of integrating refrigerant recovery systems into educational settings such as automotive training programs has been well-documented in the existing literature [9]. Several studies have highlighted the effectiveness of hands-on training in improving students' understanding and proficiency in refrigerant handling, as well as the potential cost savings and environmental benefits associated with the implementation of such systems.

A study conducted by the Auto Mechanic Training Centre (AMTraC) examined the impact of a training program on the knowledge and skills of automotive technicians in a developing country [10]. The researchers found that the training program significantly improved the participants' ability to properly handle and recover refrigerants, leading to a reduction in the improper disposal of these substances. The study also highlighted the potential cost savings associated with the recovery and reuse of refrigerants, as well as the environmental benefits of reducing greenhouse gas emissions.

Similarly, a study investigated the integration of refrigerant recovery systems into automotive technology curricula [11]. The researchers found that the inclusion of hands-on training with these systems not only improved students' technical skills but also increased their awareness of the environmental impact of improper refrigerant handling. The study recommended that educational institutions prioritize the integration of refrigerant recovery systems into their training programs to better prepare students for the industry's evolving demands.

In addition to the benefits of hands-on training, the literature also emphasizes the importance of cost-effective solutions for the implementation of refrigerant recovery systems in educational settings. A study explored the development of a refrigerant recovery system that could be easily integrated into existing automotive training facilities [12]. The researchers demonstrated the feasibility and effectiveness of this approach, highlighting the potential for educational institutions to adopt similar solutions and provide students with the necessary practical skills without incurring significant financial burdens.

The existing literature has laid the groundwork for the current research proposal by demonstrating the importance of addressing the issue of refrigerant recovery in automotive education and the potential benefits of implementing cost-effective solutions. These studies have shown that by integrating refrigerant recovery systems into the Autotronics laboratory, the College of Technology can not only improve the practical skills of its students but also contribute to environmental sustainability and cost savings for the institution.

Conceptual framework

Input-Process-Output (IPO) framework is a model that consists of concepts that are broadly defined and systematically, organized to provide a focus of the study. This framework emphasizes the flow of the study and specifies the relationship between Input, Process and Output variables.

Methodology

The methodology of this proposed study is anchored on the objectives of the researcher which covers the design, development, and evaluation of a refrigerant recovery system that can be integrated into the air conditioning trainers in the Autotronics laboratory. However, conducting a comprehensive review and analysis of relevant baseline research is important to establish compelling references. The noteworthy references will form part of the process of addressing the specific objectives of the study. This study will utilize a mixed-methods approach, combining both qualitative and quantitative methods to ensure a comprehensive evaluation of the refrigerant recovery system.

Research Settings

This study was conducted at the University of Science and Technology of Southern Philippines (USTP), specifically within the College of Technology, Department of Autotronics.

Respondents of the Study

The respondents for this study comprised twenty (20) experts in automotive technology. This group included instructors with experience in training students on automotive air conditioning systems, as well as industry professionals with a minimum of five years of experience in automotive air conditioning repair and maintenance.

Data Gathering Procedure

This study employed a phase-by-phase development methodology to design, develop, of a Refrigerant Recovery System Trainer for Autotronics Technology within the context of Automotive Technology

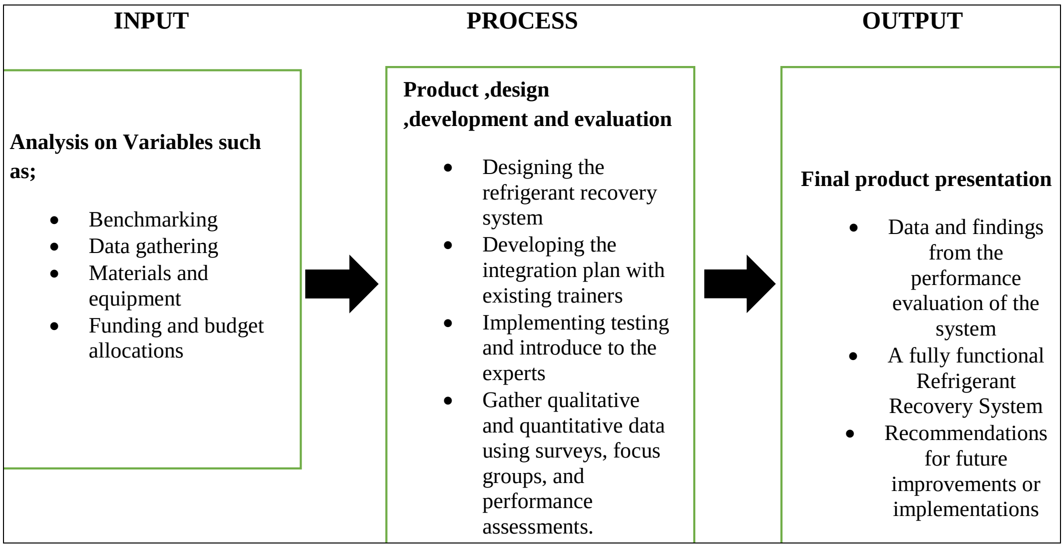

Fig 1: Shema of the Study

Input

Phase 1: Preliminary Project Analysis

A. Conduct surveys and interviews with faculty, and industry experts, to identify the specific requirements for the refrigerant recovery system. This step help determine essential features that align with educational needs and industry standards.

Fig 2: Sharing ideas for the proposed project with instructors

B. Materials and equipment involve in developing the project, this will include the priority materials that will be use in designing and development.

Process

Phase 2: Development of Prototype

Based on the identified training and assessment requirements, and informed by expert and instructor input, conceptual designs for the refrigerant recovery system were developed. These designs served as the basis for defining the system's technical specifications.

Fig 3: Development of frame

Fig 4: Develop and assemble parts of A/C recovery system

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