International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

An Automated Waste Collection System by using of Trash Chute for Hi-Rise Residential Buildings

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Abstract – *As rapidly growing cities are forcing to build Hi-rise residential buildings. In this scenario, the garbage collection from every floor & its disposal has become a challenging job. An Automated Trash chutes are the means to overcome the above problem with ease & utmost hygiene.*

An automated trash chutes consists of waste inlet connected to central connection station located at a certain place. Waste is transported at high speeds through a system of underground pressurized tubes hidden below the streets. It arrives at the central plant for further processing –recycling, disposal etc. There are advantages with using an advanced building automation system:-

- *Reduced air impurities and particles*
- *Safer, cleaner and more hygienic urban environments*
- *The system is always accessible – 24/7/365*
- *Makes recycling easier*
- *Intelligent waste collection as a result of being able to analyses regular habits and use the intelligence to promote positive change*
- *Green solution - Cleaner environment.*

***Key Words*: Pneumatic, AWCS, Trash Chute, Recyclable, Sustainability and Smart.**

1. INTRODUCTION

1.1 General

Due to excess packaging, disposable consumer products, convenience food and household wastes; it is an unfortunate fact of modern living generates huge amount of waste in High rise Residential Apartments. Finding ways to keep all this garbage from cluttering spaces, littering the ground, clogging the streets and contaminating vital waterways can be a challenge.

High-rise residential towers need to have a fast and economical way of collecting and disposing garbage generated daily. It is highly impractical to have the building management staff collect trash door to door, nor do they prefer that the residents carry trash in the lifts. The simplest solution to this problem is a centralized automated waste collection system that enables users to dispose garbage at their convenience, at their individual floors.

A Chute is a vertical or inclined plane, channel, or passage through which objects are moved by means of gravity. Refuse chute system is provided in multistoried buildings for transporting and collecting in a sanitized way the refuse from floors at different heights.

Automated waste collection system utilizes the vacuum collection system consisting of underground pipes that automatically transports waste collection chamber to a central terminal or treatment facility. At the central plant, further process is executed to dispose or recycle.

1.2 Automated Waste Collection System

An automated waste collection system (AWCS), also known as pneumatic refuse collection, or automated vacuum collection (AVAC), transports waste from trash chute system i.e installed in apartments to centralized collection system at high speed through underground pneumatic tubes where it is compacted and sealed in containers. When the container is full, it is transported away and emptied. The system helps facilitate separation and recycling of waste.

Fig -1: System of AWCS

An automated waste collection system can handle multiple waste types concurrently. One refuse chute is used for each separate waste stream. Typically, two to four separate waste streams are handled in a pneumatic refuse system using the same transport pipe network. One refuse chute is used for each separate waste stream. Typically, two to four separate waste streams are handled in a pneumatic refuse system using the same transport pipe network. In the collection station each waste stream is directed to a designated container. By collecting each waste type separately the system safeguards that waste and recyclables are not mixed in the system. The major objectives of an automated waste collection system are:

- Collection of refuse and recyclables close to the point of origin.
- Automated transport of waste and recyclables from the deposit point to the collection station.
- Minimization of manual handling
- Minimization of environmental impact such as energy consumption, gaseous emissions littering etc.
- Reduction of waste volume through recycling.

1.3 Components of AWCS

a) Trash Chute

Trash Chutes is a waste disposal equipment used mainly for easy and efficient disposable of waste in hi-rise residential buildings. The refuse is received from the successive floor through the inlets located on the vertical system of pipes that convey refuse through it and discharge it into the collecting chamber from where the refuse is cleared at suitable intervals. It can easily be installed in any duct, common lobby, landing, staircase, mid landing, utility duct, dry balcony and kitchen.

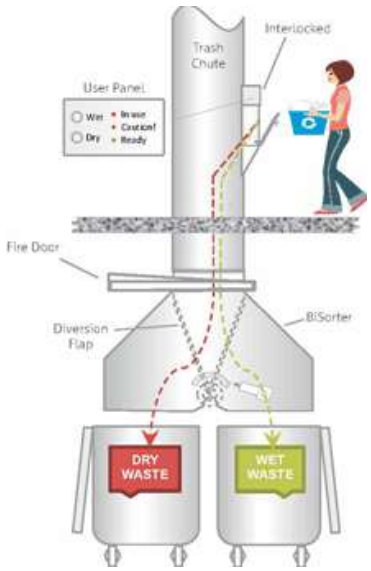

Fig -2: Trash Chute System

This chute helps in segregation of dry and wet waste that generated in residential buildings. It can be available in different Materials like Stainless Steel (Stainless steel is highly resistant to the humidity, acid and alkalis contained within refuse) and another one is Galvanized Steel. NFPA prescribes that chutes should be a minimum 24" wide. These are available in variety of thickness and size as per building height and the table given below-

Table-1- Sizes of Trash chute with Height of Apartments

Chute Size	Apartments per chute
> 450 mm	20+
> 500 mm	30+
> 600 mm	40+
> 750 mm	60+
> 800 mm	75+

The various accessories of Trash Chute are intake Hopper door, segregated garage Chute doors, vent and exhaust fan. This inclusion of automatic or manual chute cleaning systems, disinfectant & sanitizing units, electrical interlocks, foul air exhaust fans, sound deadening and fire control equipment.

An automatic 1 or 2hr fire door will be located underside of the first floor of the chute and 1.5hr rated sealed hopper doors provide a high level of smoke and fire protection.

b) Trash Compactor

The chute directly terminates into a compactor. Falling waste automatically activates the compaction function and waste is pressed together by a high tonnage ram. Compacted waste takes lesser space to store and hence fewer trips by maintenance team to clear the rubbish.

In buildings where waste generation volumes are depending on higher number of occupants, floors or waste intensive etc., a compactor is used. Compaction of dry waste can lower volumes of waste by as much as 80%.

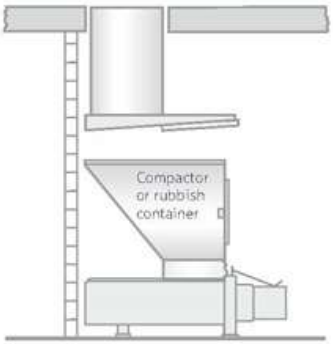

Fig -3: Trash Compactor

c) Pneumatic Pipes

Pneumatic pipes transports waste at high speed from the trash chute of building to centralized collection system through underground pipe network using full vacuum technology. This pipes are the main component of an automated waste collection as this helps in the application of compressed air (pressurized air) to power machine or control or regulate pipe network system.

That's why an Automated Waste Collection system also known as Pneumatic waste system.

Pneumatics can also be defined as the branch of fluid power technology that deals with generation, transmission and control of power using pressurized air. Gas in a pneumatic system behaves like a spring since it is compressible. Any gas can be used in pneumatic system but air is the most usual.

Fig -4: Pneumatic Pipes Network

The main network typically comprises 500 mm diameter steel pipes that are hermetically welded. Any major wearing of the pipe is the result of abrasion by the transported material, in particular, hard and edgy materials such as glass or metal refuse with the most significant pipe wear occurring at bends. These can be fitted with durable bend fittings made of titanium if it is economically suitable for the users. The reasons why pneumatic system used in this technology as follows-

- Air is available in unlimited quantities
- Compressed air is easily conveyed in pipelines even over longer distances
- Compressed air can be stored
- Compressed air need not be returned. It can be vented to atmosphere after it has performed work
- Compressed air is insensitive to temperature fluctuation. This ensures reliable operation even in extreme temperature conditions
- Compressed air is clean. This is especially important in food, pharmaceutical, textile, beverage industries
- Operating elements for compressed air operation are of simple and inexpensive construction.
- Compressed air is fast. Thus, high operational speed can be attained.

Fig -5: Pneumatic Waste Collection System

1.4 Working of AWCS

The AWCS can be categorized into 3 key separate parts:

(1) The loading stations,

(2) The transport network, and

(3) The central waste handling facility.

The collection cycle starts at the loading station points of the apartment buildings, where household wastes into colored bags. Green for food waste, Orange for Plastic packaging, Yellow for Paper and the white bag for residual waste.

These bags will be distributed to all residents by the owner. When the waste bags are full they taken to the trash chute inlets location. It is important that the bags are closed properly with a double knot. Then unlock the inlet door by switch button that is on the left side of the trash chute door. The color of the bag should be scanned, once this is done the bag is disposed of through the inlets door. After that these wastes bags transported through the chute to trash compactor. Once this trash compactor is full the AWCS activates the bags are released into the underground transport network pipe where the pneumatic pressure is used to move the bags to the collection station. When the container (that are in the collection station) is full, it is collected by a truck. The collection of the container only takes a few minute.

The truck then takes the container to the nearby separation station. The container is emptied into the hopper and a conveyor belt moves the waste bags into the optical separation station.

The bags are automatically sorted accordingly to their color. The separated bags are removed to various treatment and recycling facilities. Food waste turned into Biogas and compost Plastic and paper packaging is recycled into new packaging and residual waste is thermally treated and converted into electricity heat which is used locally.

The system is fully computerized and automated and any anomaly in functioning is indicated at the control centre by alarm signals. The frequency of the emptying cycles is easily changed in line with localized circumstances and additional discharging may be programmed for particular areas with higher waste output (food courts, restaurants, etc) at peak times, or on particular days.

1.5 Operation

The refuse collection is automated. Manual assistance or supervision is generally not required.

A computer located in the central control panel in the collection station controls and manages the collection process. The collection process is generally repeated two to

five times per day (depending on waste amount and storage capacity in the inlet).

The collection duration varies from 15-20 minutes (small systems), 30-60 minutes (medium systems) and several hours for larger systems. In between the collection cycles the system is idling. The refuse and recyclables can, however, be loaded into the system disposal points when idling.

2. SUSTAINABILITY AND SMART

AWCS technology allows waste collection to become sustainable, smart and more cost-efficient. This system transforms city centers and residential areas into cleaner, more inviting places.

Pneumatic waste collection systems can be installed in existing city centres and integrated into the city's architecture. More and more cities are becoming aware of the costs associated with traffic jams, littering, noise and emissions. These create health risks, lower the living standard for residents and weaken the city's image and brand.

A normal assumption is that automated systems are more energy efficient and produce less greenhouse gases than conventional method due to reduction I the use of diesel powered trucks. This used to create a suction in the pipe system consume significant amount of electrical energy, with associated CHG emissions. When that is added to truck transport hat is still required for bulky waste collection and the transport from the central collection station, careful analysis is required to determine a CHG reduction on a project specific basis.

An automated waste collection system into a smart system so that it can be easily integrated in any smart city infrastructure. For this purpose, the Internet of Things platform for the automated waste collection system provided by the project will allow real time monitoring and communication with central systems.

3. ADVANTAGES AND DISADVANTAGES OF AWCS

Table-2- The table shows advantages and disadvantages of AWCS –

S.NO	Advantages	Disadvantages
01	Release space in the surface and improve aesthetics.	Pipe blockages can occur.
02	Reduced operation and maintenance costs leading to cost savings in the long run.	High investment cost required in the initial phase.
03	Ability to properly collect the main waste streams.	Unsuitable for the management of large items and liquid waste. Difficulties when handling cardboard and glass waste.
04	Able to manage high volumes of waste. Ideal for high populated areas.	Not recommended for low populated areas due to economic reasons.
05	High adaptability to varying topography, including slopes, climatic conditions and space limitations.	Modifications after installation are costly.
06	Avoid the usage of garbage trucks in the collection area.	Truck usage is still needed for transportation after the collection station.
07	Better working conditions. Noise, odour and hygienic problems are minimized.	Qualified workforce is required.

4. CONCLUSIONS

The development of sustainable and smart technology for the municipal waste is becoming a mandatory requirement for smart cities. This AWCS can be countered by the long term economic benefit of reduced operational and maintenance costs, reduced leasable space utilized by waste rooms in developments and safety. The benefits can be significant reduction in collection vehicle movement, reduced traffic congestion, reduces human efforts improved visual amenity, hygiene, noise and odour. This system proposed has been a very reliable for the Hi-rise residential building and makes the building smart in a way.

However, this system no necessarily provide CHG reductions as one might assume and further research along with reason helps in justification.

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