Research paper on "Artificial Snow Equipment"

Akash A.Ghaste, Prof.S.S.Bhate, Prof.Y.A.Patil

***Abstract*— Formation of snow with the help of artificial snow equipment is also called as a real snow.**

Snow is nothing but minute crystal of frozen water at ambient temperature of less than 0^0c.

Artificial snow equipment aims at internal mixing of compressed air of 12.41 bar and pressurized chilled water of 8.96 bar at an angle of 45^0.compressed air is passed through specialized air nozzle of reducing cross section area Where temperature and pressure of compressed air will be cold be cold enough to atomize the pressurized chilled water thus atomization of air and water results in production of minute crystals of snow.

***Index Terms*—Artificial snow, real snow, snow equipment.**

I. INTRODUCTION TO PROBLEM

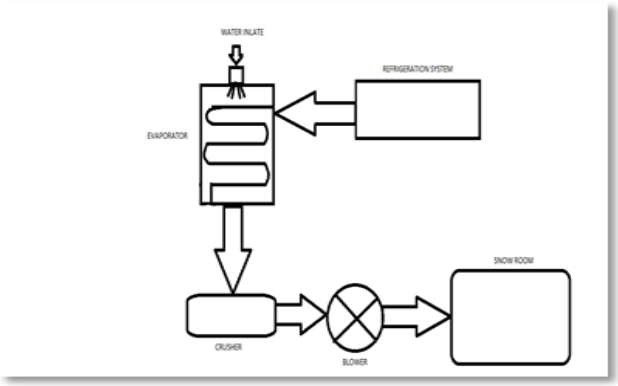

Fig: conventional snow equipment
Source: drawing by author

In today's world, the most used snow equipment is external snow gun equipment which has some disadvantages that runs on vapor absorption refrigeration system

1. The space requirement for external snow gun is nearly 1500sqft which is quite more.
2. The external snow gun requires 100hp of load which is quite more.
3. The external snow gun requires 90amp of current which is quite more.
4. The maintance cost and maintenance of external snow gun is more.
5. External snow gun requires refrigerant R22 for production of snow which is going to be banned from year 2020.
6. The external snow gun is attached with blower system due to which snow play facility is not possible.

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Akash Anil Ghaste, Shiv Shakti HSG Society, Plot no 15 'RATNABHANU' Morewadi, Kolhapur, Maharashtra, India. **Pin:** 416013 **Phone No:** 02312636284 Cells: 8888540066, 7066973181

To tackle this problem we have found solution
That is "Artificial Snow Equipment"

Objectives

1. To minimize the space requirement by proposing internal mix air water gun i.e. artificial snow equipment
2. To minimize the load current maintenance by implementing the internal air/water mixing snow gun.
3. Elimination of R22 gas by implementing internal air/water snow gun to produce snow
4. Uniform distribution of snow in snow plays facility.

II. METHODOLOGY

- Paper on artificial snow equipment stated with survey of various literature and patents documents.
- Studied various patents documents on internal snow gun arrangement
- Studied design procedure for snow gun arrangement.
- Studied design procedure for air nozzle arrangement.
- On the basis of design water pressure was decided.
- From above study angle for internal mixing of
- Air and water in gun was decided to be of 45^0.

Experimental details:

Components of internal mix air/water gun

Sr. No.	Component	Quantity
a.	Nozzle	1
b.	Air valve	1
c.	Air compressor	1
d.	Water lifting pump	1
e.	Hose line	1
f.	Fluid reservoir	1
g.	Air receivers	1

Description

1. Nozzel :

Fig: Nozzel
Source: photo by author

Nozzle to be used for air should be of mild steel having small diameter 2mm and large diameter 11mm having length of 63.5mm with internal taper angle of 4^0.

2. Air valve

Fig: air valve
Source: photo by author

Air valve to be used should be of hand operated valve made up of fine quality material with hand operated lever ergonomically designed.

3.Air Compressor

Fig: air compressor
Source: photo by author

Compressor to be used should generate pressure equal to 8.96bar and it should uniformly supply the compressed air to the gun
The compressor should be of reciprocating or rotary type. For reciprocating compressor the fluctuations of pressure is observe so my recommendation is to use rotary compressor

4. Water lifting pump:

Fig: water lifting pump
Source: photo by author

Water lifting pump should be used of 3hp also we can use 1.5 hp of chilled water lifting pump.

The water pump should be selected in such a way that discharged pressure should be of 8.96 bar so that finely atomization of water due to cold air could be possible.

5. Air and water hoses :

Fig: Air hose
Source: photo by author

Air and water hoses should be selected in such a way that it should sustain high pressure.the air hoses should capable of sustaining pressure of 12.41 bar and water hoses shoud sustain pressure of 8.96 bar hoses generally made up of rubber should be selected

Working

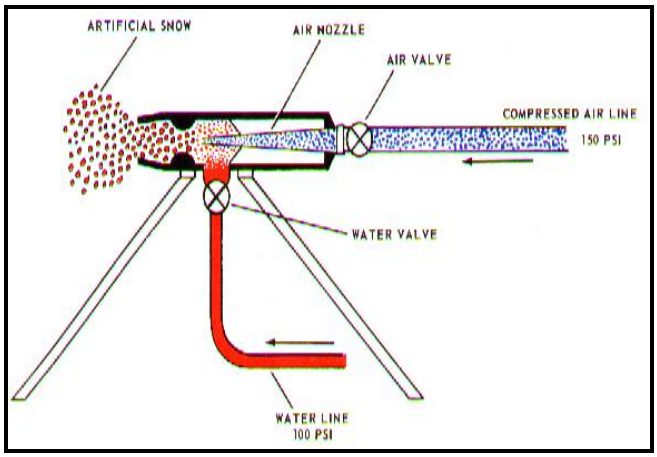


Fig: Artificial snow equipment principle
Source: Google images

III. PRICIPLE OF WORKING:

The working of artificial snow equipment is based on following principle:

1. Boyles law states that the absolute pressure of given mass of perfect gas varies inversely as its volume ,when temperature remains constant.
   PV=constant
2. charles law states that the volume of given mass of perfect gas varies directly as its absolute temperature ,when the absolute pressure remains constant.
   V/T=constant
3. Gay-lussac law states that the absolute pressure of a given mass of a perfect gas varies directly as its absolute temperature ,when the volume remains constant.
   P/T=constant

Artificial snow equipment is the internal air/water mix snow gun constructed by simple nozzle arrangement in which

presurised water and compressed air are mixed together the ambient condition or atmospheric temperature should be strictly below 0^0c

The chilled water generally between 3^0c to 1^0c is pumped from chiller water plant.

The compressed air always enters from the rear of gun, correspondingly the chilled water also enters at 45^0in the gun .the compressed air is then passed through specialized nozzle where pressure and temperature of air drops at the exit point of the nozzle. The chilled water is then passed at an angle of 45^0.

The atomization process occurs when the stream of compressed at of compressed air at 12.41bar shatters and penetrates the bulk water coming at 45^0 to the air nozzle stream into tiny droplets of water giving the water a much larger ratio of surface area to volume, thus allowing evaporative cooling as well as sudden expansive cooling effect which nucleate the water droplets.

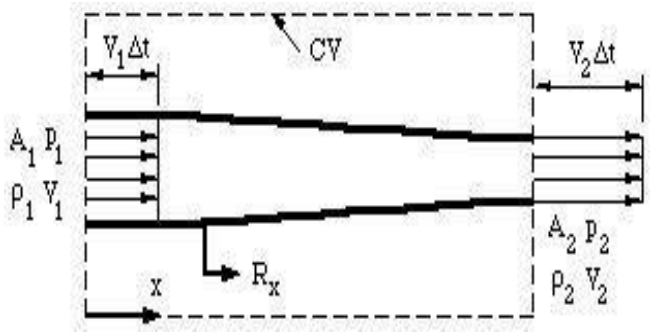
Compressed air which exits from the gun creates the mans of spraying minute automised water droplets onto the slope.

Compressed air which enters the gun at 12.41bar and quickly returns to atmospheric pressure after exiting the gun

If we drop the ambient temperature and increase the flow in gun this will also increae the snow formation process.

My investigation have shown that compressed air capacity is directly proportional to the snow production.

IV. CALCULATIONS:



Bernoulli's theorem: In steady ideal flow of an incompressible fluid, the total energy at any point of the fluid is constant

The total energy consists of pressure energy, kinetic energy, datum energy.

$$p + \frac{1}{2}\rho V^2 + \rho g h = constant$$

where p is the pressure, ρ is the density, V is the velocity, h is elevation, and g is the gravitational acceleration

$$\text{volume flow in over } A_1 = A_1 V_1 \Delta t$$
$$\text{volume flow out over } A_2 = A_2 V_2 \Delta t$$

Therefore

$$\text{mass in over } A = \rho A_1 V_1 \Delta t$$
$$\text{mass out over } A = \rho A_2 V_2 \Delta t$$

$$\text{So: } \boxed{\rho A_1 V_1 = \rho A_2 V_2}$$

According to continuity equation:

$$p_1 - p_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$$

$$\text{and } A_1 V_1 = A_2 V_2$$

Therefore,

$$A_2 < A_1, \quad V_2 > V_1$$
$$V_2 > V_1, \quad p_2 < p_1$$

decreasing area = increasing velocity
increasing velocity = decreasing pressure

Calculations of nozzle Air discharge:

Air discharge is measured by formulae

$Q = K [P]^{1/2}$

Q = Flow in l/s or l/m.

K = constant for specific nozzle.

P = Pressure at the nozzle.

Calculation of friction loss through pipe is based on Hazen and Williams formulae

$P = 6.05x10^5 x [Q^{1.85} \div [C^{1.85} x d^{4.87}]$

P = friction loss in bar/meter.

Q = Flow in liter/minute

C= Constant

d = inside diameter of pipe in mm

Calculation of water discharge

Water discharge is measured by formulae

$Q = K [P]^{1/2}$

Q = Flow in l/s or l/m.

K = constant for specific nozzle.

P = Pressure at the nozzle.

Calculation of friction loss through pipe is based on Hazen and Williams formulae

$P = 6.05x10^5 x [Q^{1.85} \div [C^{1.85} x d^{4.87}]$

P = friction loss in bar/meter.

Q = Flow in liter/minute

C= Constant

d = inside diameter of pipe in mm

Calculation of velocity

$V = Q \div d^2$

V. ADVANTAGES:

1. Energy saving is done on large scale.
2. Space requirement is less.
3. Snow can be easily made in home also in winter season.
4. Elimination of refrigerant R22 for snow formation.
5. Ecofriendly system.
6. Quality of snow is rich and fine.

LIMITATIONS:

1. Skilled and trained workers are required..

VI. CASE STUDY:

Case study of Kent club, sad hale mad hale, near top sambhapur, Kolhapur, Maharashtra, India

The Kent club, at sad hale mad hale in Kolhapur district. Uses ice making refrigeration system which is kind of conventional external air/water mix gun. In which there is a cylinder which itself acts as evaporator .surrounded by coils carrying refrigerant

R22.as the R22 will be banned by 2020, the other

Refrigerants are costly which not affordable. Also power consumption by this system is more hence requirement of new system arises.

This gave an idea of internal air/water mix air gun.in which compressed air at 12.41bar.Pressurized water at 8.96bar is used.in this System. The ambient temperature was -8^{0} c air is passed through nozzle which acts as an expansion device which lowers the pressure and temperature of compressed air by providing larger surface/area ratio .further passing through the orifice the pressure and saturation temperature drops below atmospheric temperature and snow is formed in the snow gun and ejected out.

VII. CONCLUSION:

1. Minimized the space requirement.
2. Minimized the load, current maintenance by implementing the internal air and water mixing gun.
3. Eliminated the use of R22 gas for snow production.
4. Uniform distribution of snow in snow plays facility room.

VIII. FUTURE SCOPE:-

1. Automation of internal snow gun.
2. Use of PLC for internal snow gun
3. Further minimization of initial cost.

IX. ACKNOWLEDGMENT:

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[3]Thesis on Calibration of Snowmaking Equipment for Efficient Use on Virginia's Smart Road by Edward Shea submitted to Virginia polytechnic and state university August 4,1994 Blacksburg ,Virginia.
[4]Refrigeration and air conditioning by Khurmi-Gupta ,chapter no 2.

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Pin: 416013
Phone No: 02312636284 Cells: 8888540066, 7066973181
Educational Qualification: B.E. MECHANICAL [LAST YEAR]
Research work:
1] Research on improving techniques of artificial snow formation by artificial snow equipment's.
2] Research on improving efficiency of copper-cuprous oxide solar cell in NACL Electrolyte.
3] Research on solar metal detector.
4] Research on advanced trends in automation of artificial snow equipment.
5] Research on energy management of hybrid solar-wind mill power plant.
6] Research on vibration acoustics.
7] Research on advance trends in refrigeration system design
Seminar: Presented seminar on "Vibration Acoustics" in D.Y.Patil technical campus Talsande, Kolhapur, Maharashtra, India.
Project: Prepared sponsored project on "Artificial Snow Equipment" in D.Y.Patil technical campus Talsande, Kolhapur, Maharashtra, India.
Experience: One month experience at "Texone foundry equipment" MIDC, Gokul Shirgoa, Kolhapur.
Extracurricular activities:
Extra-curricular Activities
1] Completed AutoCAD course.
2] Participated in National level technical event INFINITY 2015 at D.Y.Patil College of engineering and technology, Kolhapur.
3] Participated in National level technical event Techvaganza 2k15 at Dr.J.J.Magdum college of Engineering, jaysingpur.
4] Participated in National level technical symposium in association with ISTE, Delhi at Ashokrao Mane Group of institutions, Kolhapur.