



Thermodynamics analyse of lantern at Dieng Culture Festival

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ABSTRACT

This study aims to determine the concept of physics in the form of weather such as rain, wind, and temperature during the flight of the lanterns in the Dieng Culture Festival (DCF) series of events. This research used qualitative research method with literature study method because the data used comes from books, journals, and other documents. The findings in this study are in the form of physics concepts in the flight of lanterns in the series of DCF events. The conclusion is that in the series of DCF events, namely the lantern festival, it can be related to physics, namely the rain and wind conditions in September are not so great that when the lanterns are blown up, they can rise but do not cause the lanterns to disappear into the surrounding villages because of the wind. In addition to the wind, rainfall also affects the Lantern Festival. When heavy rainfall will cause the lanterns to not fly because the heat cannot meet the volume of the lanterns. August to September 2022 is a pretty good month because the wind isn't too fast, the rainfall isn't too dense and the ambient temperature isn't too cold.

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1. INTRODUCTION

Indonesian culture which has a broad scope in which one of the main aspects is related to local wisdom. Local wisdom is defined as a way of life and knowledge as well as life strategies in the form of activities led by community leaders, because Indonesian society consists of various tribes and cultures. Indonesia is a country with diversity and wealth culture (Bagus Brata, 2016). One of the local wisdoms in the Wonosobo and Banjarnegara areas, especially for the area around the Dieng mountains. Apart from being known as climbing track tourism, and for the last ten years village community held the Dieng Culture Festival (DCF). Dieng cultural festival has the idea of synthesizing elements of community culture, Dieng's natural tourism potential and local community empowerment. The aim of organizing the annual DCF is to preserve local cultural traditions, attract tourists and increase the creative economic potential of the Dieng people. Dieng culture is not only understood as dance or related to art, but Dieng culture includes beliefs in the tradition of shaving rituals, knowledge about the origins of traditions, as well as standards and customs that are maintained by the community and the practice of farmer life in fulfilling needs. their family (Nailatul Fauni et al., 2022).

The weather at Dieng has played a significant role in this event. Dieng Plateau is volcanic complex located at 1500 – 2000 m above sea level, it caused a climatic condition that provide a fertile soil for agriculture. The low temperature in Dieng Plateau has a phenomenon around July to August where the temperature reached a very low sometimes reach minus called Embun Upas. The phenomenon of Embun upas on the Dieng Plateau occurs during the dry season when the phenomenon of Embu upas on the Dieng Plateau occurs during the dry season when the temperature is below zero. This phenomenon causes freeze damage to plants that freeze through the outer leaf tissue of thin-leaved plants caused by INA bacteria.(Firdaus et al., 2023)

Lantern is a simple form of hot air balloon that use a help of wind of surrounding, in DCF has a simple form of lantern close to cubic or open cylinder. Hot air balloon use a measurement from global navigation satellite system (GNSS) to measure displacement during a time interval and a certain speed. The hot air balloon is use as passive platform for observations (de Bruijn et al., 2016). Lantern was not use as meteorological data but for village festival that hold around august to early September. The vertical profiles of wind, temperature, and humidity measured with these coarse detectors are used to constrain global circulation patterns (GCMs) and improve the accuracy of weather forecasts (Ethé et al., 2002).

Observations from previous studies indicate that the local community or the general public are not aware of the local intellectual values embodied in the DCF program. Many people come as mere entertainment (festival) without seeing the meaning values that exist in each event. For example, when the holiest event is curing or cutting dreadlocks, fewer people attend than during Jazz in the Clouds or the lantern festival (Nailatul Fauni et al., 2022).

Dieng Culture Festival series of lantern events is interesting to discuss the physics of the process of releasing or flying. Lanterns come in various forms, both detachable and stationary. The presence of various types of lanterns always pays attention to the value of it is beauty (Rokhmat, 2009). The beauty of the lantern at first appeared as a lighting lantern using a translucent material. With a covering material used to prevent the flame from being extinguished due to wind or ambient air to maintain the light source. Paper-making technology originated in China in 105 AD during the Han dynasty, which was then used as the covering for lanterns (Lindell et al., 1951).

Behind the intricate design and beautiful light, lanterns also convey a deeper meaning. They are often interpreted as symbols of life, change and travel. The tradition of releasing lanterns into the night sky has become a way for many people to symbolize letting go of hopes, worries, or memories they carry with them. In that moment, a lantern is not just a light, but also a representation of deep human feelings.

When the lantern is released upwards and flies up to a certain height then it runs out and falls back to the ground. Physics studies used such as ideal gases and thermodynamics for example. Or in other words, the existence of flying lanterns is an example of the concept of an ideal gas and thermodynamics in everyday life. An ideal gas itself is a theoretical gas consisting of point particles that move randomly and do not interact with each other. While thermodynamics is the science that studies the relationship between energy and work of a system (Rusman, 2018).

2. METHOD

Methods in this research use “a theoretical framework” from an existing literature which is a structure that summarizes concepts and theories developed from previously tested and published knowledge. To create this framework, we conducted a literature search of coordination models, frameworks, and theories (Kivunja, 2018). Due to the ambiguous nature of the concept of coordination and the review of the various existing systematic reviews, we decided to base these assessments on.

A review of literature reveals that there are conditions that make coordination necessary and determines the extent to which it is necessary. So we have divided this section into two parts. (1) precondition for the need of coordination and (2) the coordination literature, with it is definitions, frameworks, and theories (Ockli et al., 2023).

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3. RESULT AND DISCUSSION

The thermodynamics of lanterns involves understanding energy conversion, heat transfer, and the behavior of gases and air. The thermodynamic processes involved in lantern culture are: (1) Source of Energy: Traditional lanterns often use candles as an energy source. The process of burning a candle involves a chemical reaction. This reaction releases heat energy in the form of light and warmth. Combustion thermodynamics involves concepts such as enthalpy change, heat of combustion, and energy conversion efficiency. (2) Heat Transfer: As the candle burns inside the lantern, heat is generated. This heat is transferred by conduction and convection. The material of the lantern plays a role in how efficiently heat is conducted through its structure. For example, a paper lantern may allow more heat to escape by conduction than a more insulated material.



Figure 1. Lantern At Dieng Culture Festival.

<https://kemenparekraf.go.id/berita/siaran-pers-menparekraf-dieng-culture-festival-potensial-jadi-event-kelas-dunia-inisiatif-masyarakat>

(3) Convection and Airflow: The movement of air around the lantern affects how efficiently heat is carried away from the candle flame. Hot air rises due to convection, pulling in cooler air from below. This process can affect the brightness of the flame and the overall temperature inside the lantern. (4) Radiation: The light emitted by a candle flame is a form of electromagnetic radiation. This light carries energy away from the flame and contributes to the illumination provided by the lantern. Radiant heat transfer is part of the energy balance within the lantern. (5) Gas Behavior: If the lantern is closed, the air inside can experience changes in pressure and temperature due to burning candles. These changes can affect the density and behavior of air. Understanding the ideal gas law and the thermodynamic properties of air can help explain these changes. (6) Loss of Energy: A thermodynamic system always experiences some degree of loss of energy, often in the form of waste heat. In the case of lanterns, some of the heat generated by the candles may be dissipated to the surroundings, reducing the overall efficiency of the system.

In thermodynamics, the kinetic theory of gases explains that gases exert pressure when molecules hit the walls of the container or barrier of the gas. The greater the amount of gas given per unit volume, the greater the motion of the molecules hitting the walls of the container which causes the gas pressure to increase. Theory assumptions for gas kinetics are

- 1) Gas consists of molecules that move randomly
- 2) There is no attraction or repulsion between gas molecules
- 3) Collisions between molecules are perfectly elastic, that is, no kinetic energy is lost.
- 4) When compared to the volume occupied by the gas, the volume of gas molecules is negligible.

$$PV = \frac{1}{3} NAmu^2 \quad (1)$$

By using the thermodynamic equation where the number of molecules $n = NA$, the average velocity is $m \cdot v^2$. Assuming that the velocity of the gas molecules is a function of the PV since the PV value for a given amount of gas is fixed, it is possible that the velocity of the gas molecules is related to the mass of the gas, i.e., its molecular mass. The buoyancy force which describes the hot air balloon in general, where V is the volume expressed as

$$F_b = Vg(\rho - \rho_i) - M_b \quad (2)$$

Where M_b is the mass of the balloon, g is the gravitational velocity and ρ and ρ_i are the air outside and inside the balloon. This equation is used as a function which is also used in lanterns. If the lanterns are semi-spherical, then the volume of the lanterns can be calculated by $V_b = \frac{4}{3}\pi r^3$. The ideal gas equation and average relative molecular mass of air are considered to be 80% Nitrogen N_2 and 20% Oxygen (O_2).

DCF held around august at 2019 and close at 2020 because of pandemic, and held on November at 2021, then held at September at 2022. Indonesia as tropical country has only two season; September to April is a dry season but as a climate change affect the precipitation and windspeed at Dieng plateau at the day of festival. the lantern has a fixed position and at moderate wind speeds, a state of equilibrium can be reached quickly based on the weather of the month.

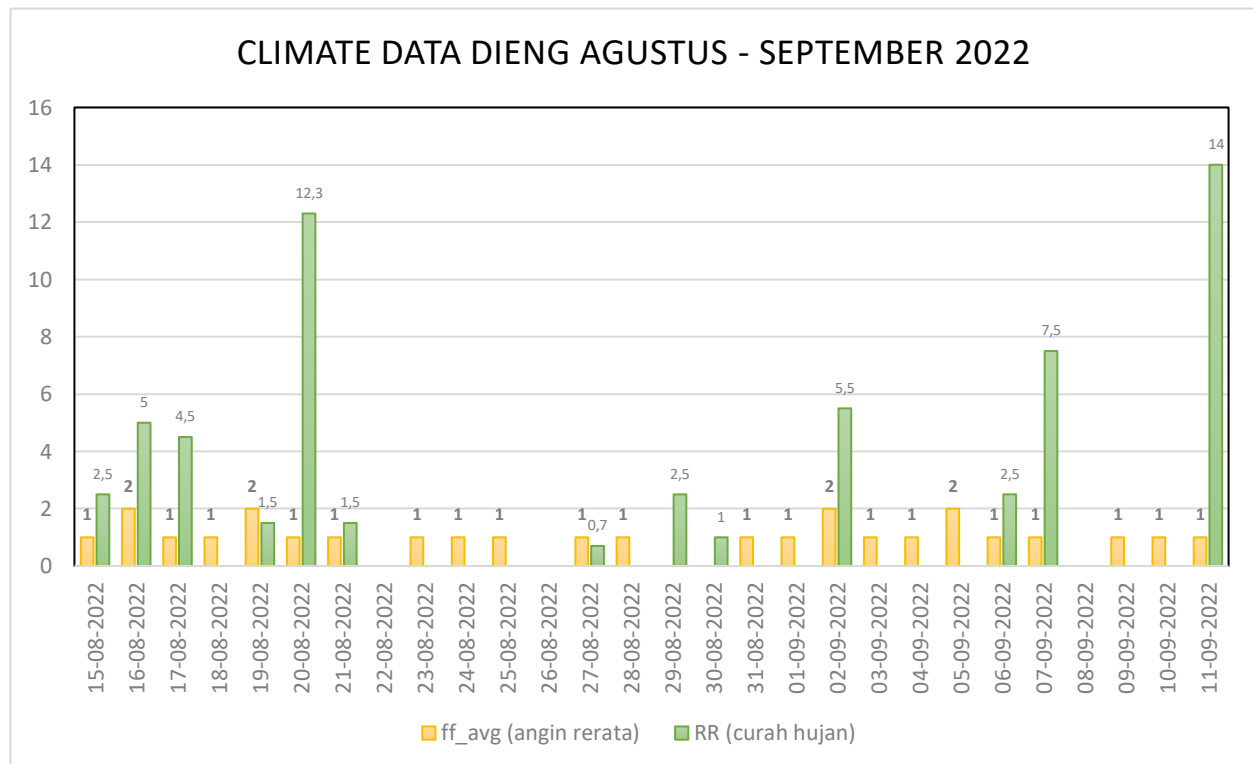


Figure 2. climate data of rainfall and wind.
(data source : BMKG)

If the lantern is filled with air of the same temperature and pressure (25°C and 1 atm pressure), the lantern will not rise because the weight of the air displaced is equal to the weight of air in the lantern. If the air temperature in the lantern is raised by around 100 °C, then the air mass in the lantern is of the appropriate volume or close to the volume of air around Dieng, so that the lantern can be flown because the air volume is lighter than the air mass to be moved.

The balloon is always unconditionally stable during flight because the balloon's weight is always concentrated at the bottom, below the center of buoyancy. The control of the hot air balloon is dependent on the operator, if the operator wants to descend, he can stop the combustion of the burner, which causes the hot air in the casing to cool naturally through heat exchange with the

atmosphere or open a slight hole in the top of the envelope, thereby releasing some of the hot air, which reduce buoyancy.

Figure 3. In addition to rainfall and wind speed that affect the day of the festival is temperature. Because the lower the daily temperature without rain will be colder than the low temperature with rain. Especially when the weather reaches a minimum temperature for a few days it causes dew as a cold effect on the environment.

Conversely, when the air is heated by burning fuel, the balloon rises in height. The hot air inside the casing builds up to a greater pressure than the surrounding air, as a result of which the balloon remains inflated. Typically, there is an opening at the bottom of the envelope through which hot, expanding air is allowed to escape, which prevents large pressure gradients from occurring. That is, the pressure of the hot air inside the balloon will be slightly greater than the pressure in the cooler surrounding air.

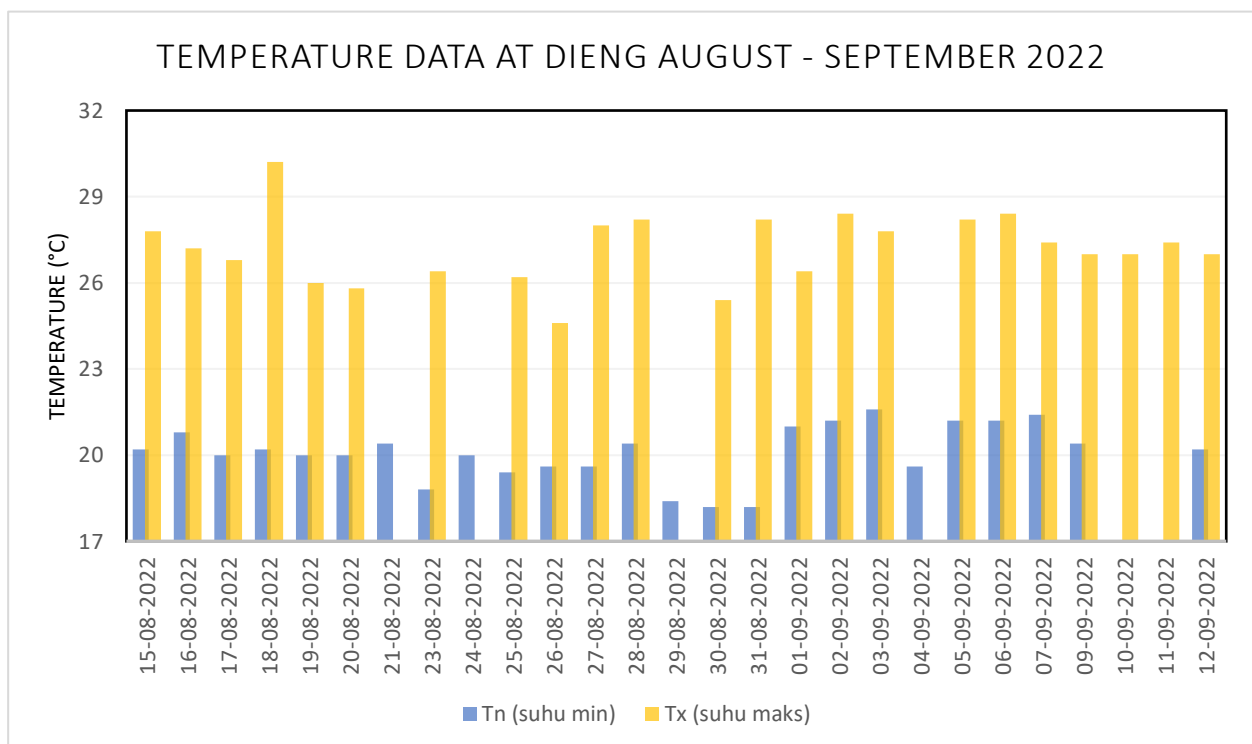


Figure 3. Climate data of temperature.
(data source : BMKG)

4. CONCLUSION

Lanterns that work on a simple principle, namely by heating the air in the lantern so that the heat enters the paper lantern space. The concept of an ideal gas in a lantern is related to the relationship between air mass transfer at 1 atm pressure and room temperature. A closed system because the lantern can fly upwards must have heat energy in the lantern which causes the air mass to remain constant and the volume to change. Weather condition in Dieng affect the Dieng culture Festival event have a big influence on the Dieng cultural festival, where the lower the rainfall of the week, the greater the chance of success of the lantern festival. A simple lantern festival that uses simple heat effects and wind from the surroundings has a big influence on success. From

weather data it is known that rainfall between August and September 2022 where rain precipitation is not heavy.

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