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Drying of celery leaves (*Apium graveolens L.*) using a PV/T solar dryer

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Drying of celery leaves (*Apium graveolens L.*) using a PV/T solar dryer

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Abstract. Celery (*Avium graveolens L.*) has been naturally used to treat hypertension and cancer. Fresh celery contains a high water content of approximately $\pm 86\%$ which may lower the quality upon storage for a long time. Drying was applied to reduce moisture content in order to prolong the shelf-life. Drying of celery was carried out using a self-designed photovoltaic-thermal (PV/T) solar dryer as well as conventional dryers such as oven and vacuum oven for the comparisons at an approximate temperature of 49°C . The PV/T solar dryer was able to simultaneously convert the solar energy into thermal and electrical energy. The electrical energy was in turn used to drive the blowers to create a forced convective flow of heat transfer. Drying in the PV/T solar dryer was carried out in 3 different weather conditions while 3 different pressures (10; 40; 70 kPa) were tested during drying in the vacuum oven. The PV/T solar dryers demonstrated the best results in terms of constant drying rate ($0.986 \text{ kg H}_2\text{O}/\text{min.m}^2$) and drying time (87 minutes). Total chlorophyll content retained was 5.42 mg/L . The PV/T solar dryer seemed promising to be further developed for an efficient drying process since it required low energy consumption while using the costless renewable solar energy.

1. Introduction

Indonesia is amongst the world's richest nations in terms of its biodiversity including plants and herbs. There are more than 30,000 herbs present in Indonesia, however only 25% of them of which medicine efficacy have been known and moreover only about 1,200 species have already been processed as raw materials for medicinal traditional herbs or so called *jamu* [1]. Celery (*Avium graveolens L.*) contains micronutrients, vitamins and phenolic compounds and widely used as herbs for lowering hypertension and for cancer prevention [2, 3]. Herbs as well as natural plants generally contain high moisture content which could accelerate the microbial growth leading to physical deterioration. An effective drying process is required to reduce the water content thus improving the shelf life of celery.



Several drying methods were conducted in order to reduce moisture content in celery [4, 5]. The most suitable drying techniques involved low temperature of less than 70°C to preserve the nutrient contents [5]. However, there has been no investigation yet related to drying of celery in a solar dryer. Solar dryer has become promising as a drying alternative for drying herbs using the renewable energy with preserved texture of dried samples [6]. The solar energy is able to be converted into thermal energy by means of a solar panel. Moreover, a hybrid solar dryer using an amorphous Si type PV/T system was capable to convert solar energy into thermal as well as electrical energy. Therefore, this system could produce high energy efficiency besides a much higher performance stability compared to the individual solar dryer [7]. This hybrid system has been increasingly applied in diverse applications due to the high demand of the use of renewable energy, especially in Europe [8, 9].

This research objective was to reduce the moisture content of celery by using a hybrid PV/T solar dryer. This self-designed PV/T solar dryer was expected to be able to convert a higher solar energy per drying surface area since the electrical energy would in turn drive the blower inducing active drying facilitated by force convection mechanism. The drying characteristics were studied and compared with those obtained by using the conventional dryers such as oven and vacuum oven drying. The bioactive content particularly chlorophyll content retained in the dried samples were also determined. The use of hybrid solar dryer could be promoted as a dryer means alternative which was pollution free while using a cost free and renewable solar energy for supporting many sustainable green processes.

2. Materials and methods

2.1 Materials

Celery (*Apium graveolens L.*) was purchased from Wonokromo local market, Surabaya, Indonesia; technical grade acetone 98% (Brataco, Indonesia); demineralized water

2.2 Drying of celery leaves

Celery leaves were separated from the rods and other parts and then cleaned to remove soils and other dirt. The leaves were subsequently cut into 2 parts whereby each part had the dimension of about 3 x 4 cm. Sample amounts of about 15 grams were weighed with the balance (Mettler, Toledo) and closely loaded into the aluminium drying pan (29 x 25 cm) in a single layer.

A self-designed photovoltaic/ thermal (PV/T) solar dryer was shown in details in Figure 1. The solar dryer was mainly made of aluminium for the body, glass roof at the top, and a drying cabinet consisting of 4 trays supported by hooks made of plywood boards. A PV/T collector connected to the solar dryer simultaneously converted the solar energy into thermal and electrical energy. It consisted of amorphous Si solar cell panel covered by glass accompanied with battery and controller system. The battery stored electrical energy that was used by the blowers to improve the air circulation. The drying pan containing samples was only put onto the first tray in the middle during the experiment. Drying of celery was conducted in 3 different days between 9.00 am until 16.00 pm with ambient air temperature ranged between 30-35°C resulting in different averaged temperatures within the drying cabinet. The air temperatures were monitored by reading the thermometer (Figure 1D) at the same time with sampling i.e. every 1 minute for the first 30 minutes, followed by every 2 minutes until 1 hour and then every 3 minutes until constant sample weight was attained. The air temperatures were then averaged.

Drying was also conducted using oven (Venticell 111 Model, Medcenter, Germany) and vacuum oven (BOV-30V Model, Biobase, China) at controlled temperature of 49°C corresponding to the optimum averaged temperature obtained in the solar dryer. Vacuum pressures of 10, 40, and 70 KPa were varied during drying at 49°C in the vacuum oven. Drying was carried out until constant weight of sample was attained within the tolerance of ± 0.005 g.

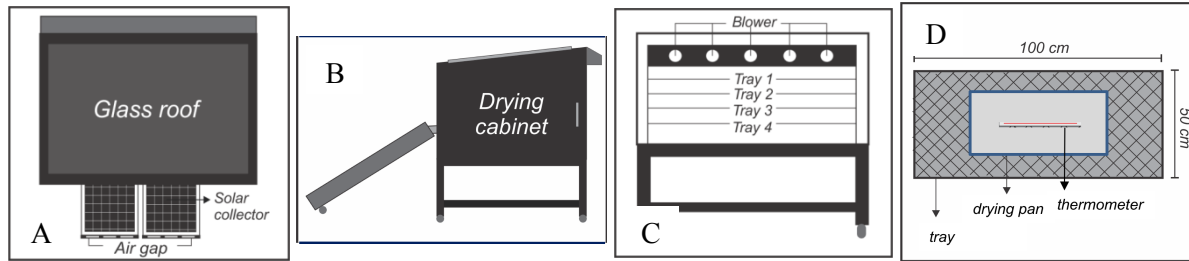


Figure 1. The self-designed PV/T solar dryer. A) Top view; B) Side view; C) Inside the drying cabinet; D) Air temperature measurement around the drying pan.

Results were presented as drying curves whereby free moisture content (X) were monitored versus the drying time [10]. Free moisture content were gained from the moisture content at certain time (X_t) deducted by equilibrium moisture content (X^*).

$$X_t = \frac{W_t - W_d}{W_d} \quad (1)$$

where X_t = moisture content at certain time (kg H_2O /kg dry weight); W_t = sample weight at certain time (kg); W_d = sample dry weight (kg) obtained after sample weight was constant after a certain time.

$$X = X_t - X^* \quad (2)$$

where X = free moisture content (kg H_2O /kg dry weight); X_t = moisture content at certain time (kg H_2O /kg dry weight); X^* = equilibrium moisture content (kg H_2O /kg dry weight).

The drying curve characteristic was also represented by the drying rate (R) versus X .

$$R = \frac{-L_s}{A} \frac{dX}{dt} \quad (3)$$

Where R = drying rate in kg H_2O /m².min; L_s = sample dry weight (kg); A = sample surface area (m²); dX/dt is the slope of linear trend line of X vs. t for the constant rate period, where as dX/dt for the falling rate period was calculated using the equation (4) which was the slope of exponential function model as shown in equation (5).

$$\frac{dX}{dt} = \frac{a}{t} \quad (4)$$

$$X_t = a \ln t + b \quad (5)$$

Finally, the loss of moisture content in %wet basis was calculated as follows.

$$\text{Moisture Loss (\% wet basis)} = \frac{W_i - W_f}{W_i} \times 100\% \quad (6)$$

where W_i = initial sample weight (g); W_f = final sample weight (g).

2.3 Determination of chlorophyll content

Celery leaves were pounded in a mortar with pestle. Afterwards 3 ml acetone solution was added into 0.02 g of celery leaves powder followed by water addition up to 25 ml in a volumetric flask. An aliquot of 8 ml was taken 3 times into different centrifuge tubes. Centrifugation was conducted for 20 seconds at 3200 rpm in a centrifuge (Shanghai, China) to separate the sediment with supernatant. The supernatant was decanted into a filter to remove out the suspended solid particles. Clear supernatant liquid of 2 ml was mixed with 3 ml acetone prior to absorbance test in a spectrophotometer (Lambda EZ 150, Perkin Elmer, USA). The absorbance values were measured at $\lambda = 665$ nm and 649 nm. Both chlorophyll A and chlorophyll B contents were calculated using the equation proposed by Wintermans and De Mots [11, 12]. Total chlorophyll content in mg/L was the sum of chlorophyll A and chlorophyll B. The absorbance measurements were conducted in triplicates at each wavelength.

3. Results and discussion

The drying characteristics of celery leaves in the PV/T solar dryers measured at 3 different average temperatures were depicted in Figure 2. It was obvious that the higher the temperature the shorter the time required to reach the equilibrium moisture content indicated by the constant sample weight. The higher drying temperature also resulted in the higher drying rate. This was in line with the previous drying study on rhizomes [6, 11]. The average temperatures measured in the vicinity of tray 1 where the drying pan was located during the experiment was within the range of 43–55°C which were relatively high compared to the ambient air temperature. The increased temperature was due to the generated thermal energy derived from the solar energy. The heat transfer mechanisms involving radiation, conduction, and forced convection influenced the overall transfer of thermal energy into the drying cabinet. The first tray received the highest thermal energy via solar energy radiation [6] through the glass roof while heat conduction occurred along the dryer walls. The solar radiation impinged into the solar panel was converted into thermal and electrical energy. The force convective mechanisms occurred as the results of self-driven blower was induced by electrical energy produced by the PV/T solar dryer. The blower induced an external force which accelerated the convective heat transfer. The simultaneous thermal and electrical energy derived from solar energy seemed quite efficient in improving the drying rate inside the solar dryer.

The drying performance in the PV/T dryer was compared with those in conventional oven and vacuum oven dryers as could be seen in Figure 3. It turned out that the highest drying rate (Figure 3B) and thus the shortest drying time (Figure 3A) was obtained upon drying using the PV/T solar dryer at the approximately similar drying temperature of ~49°C. The constant drying rate of ~16 times and ~4 times higher compared to those of oven and vacuum oven respectively as seen in Table 1. The constant drying rate obtained from this PV/T solar dryer was much higher with the order of about 2 compared with the previous developed solar dryer without self-driven blower [6]. The lower constant drying rate obtained by using the conventional dryers ($< 0.3 \text{ kg H}_2\text{O}/\text{min.m}^2$) was due to the lower rate of convective heat transfer in contrast to the PV/T solar dryer ($\sim 1 \text{ kg H}_2\text{O}/\text{min.m}^2$). This was also reflected by the highest moisture loss of about 82% and shortest drying time of about 87 min obtained upon celery drying in PV/T solar dryer.

The celery drying in the oven required a shorter time compared to that required in the vacuum oven though the constant drying rate obtained in the vacuum oven was higher than that obtained in the oven. The oven was equipped with a small blower enabling the air circulation and forced convective heat transfer mechanism which accelerated the drying process. In the vacuum oven, the vacuum pressure played a significant role in lowering the boiling point of water in spite of quite low convective heat flow inside the chamber. The lower pressures tended to reduce the drying time although only fair differences were noticed.

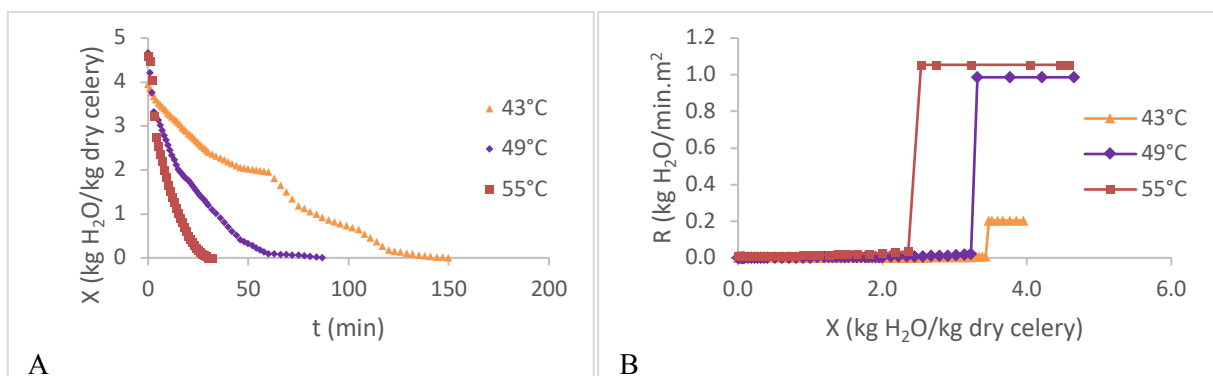


Figure 2. Drying curves characteristics of celery leaves at different averaged drying temperatures in the PV/T solar dryer. A) Free moisture content vs. time; B) Constant drying rate of celery leaves vs. free moisture content

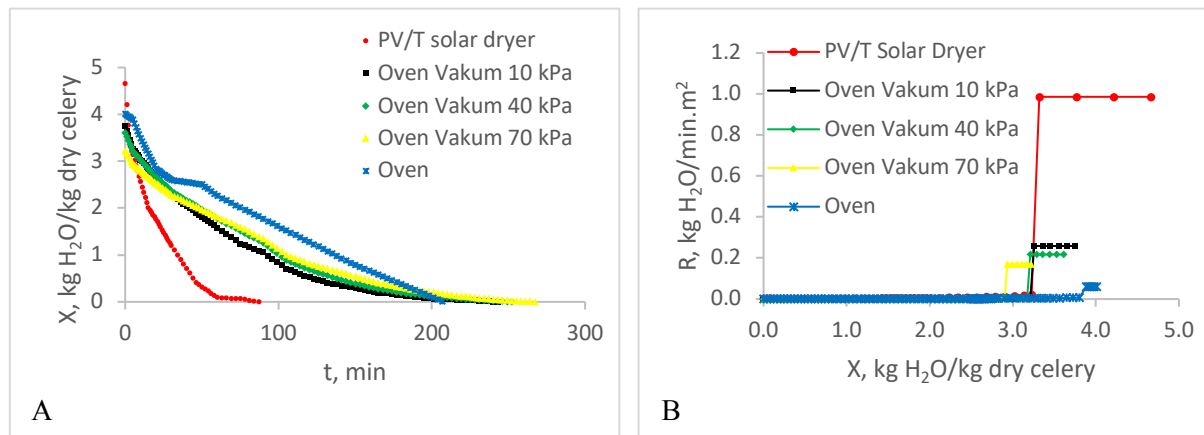


Figure 3. Drying curves characteristics of celery leaves at drying temperature of approximately 49°C in various dryers. A) Free moisture content vs. time; B) Constant drying rate of celery leaves vs. free moisture content

Table 1. Comparisons of drying time, constant drying rate, moisture loss and chlorophyll content during drying of celery leaves in various dryers at various drying conditions.

Types of dryers	Drying condition		Drying time (min)	Constant drying rate, (kg H_2O /min.m ²)	Moisture loss (% wet basis)	Total chlorophyll content (mg/L)
	P (kPa), Boiling point(°C)	T (°C)				
PV/T solar dryer	101.35 (100°C)	43	150	0.204	79.76	5.71 ± 0.027
	101.35 (100°C)	49	87	0.986	82.1	5.42 ± 0.040
	101.35 (100°C)	55	32	1.054	82.07	5.37 ± 0.020
Oven	101.35 (100°C)	49	207	0.060	79.3	5.48 ± 0.064
Vacuum oven	70 (89.64°C)	49	267	0.171	76.2	7.51 ± 0.086
	40 (72.45°C)	49	252	0.217	78.2	7.74 ± 0.022
	10 (45.81°C)	49	243	0.259	78.9	7.85 ± 0.110
Fresh celery	-	-	-	-	-	9.45 ± 0.015

Finally, the chlorophyll content in the dried celery was determined to study the retention of a sort of bioactive content after the drying process. The total chlorophyll content decreased of about 17-40% after the drying process as depicted in Table 1. This huge decrease in chlorophyll content could be caused by the milling process generating higher heat effect for the dried samples compared to fresh samples. The highest total chlorophyll content was retained in the samples dried using vacuum oven whereas chlorophyll content of celery dried in PV/T solar dryer was similar with that dried in the oven regardless the length of drying time. Slow drying process accompanied by the water evaporation at a much lower temperature seemed slow down the chlorophyll deterioration. Chlorophyll seemed to be sensitive towards drying temperatures as well as drying rates. The experimental results implied the great potential of PV/T solar dryer in substituting the use of energy intensive conventional dryers such

as oven and vacuum oven. The renewable and cheap solar energy should be more intensively and optimally used to enhance the sustainable process particularly in drying process of herbs or plants in the tropical country.

4. Conclusions

Drying of celery leaves in the self-designed PV/T solar dryer seemed superior in comparison with the other conventional drying methods such as oven and vacuum oven dryer in terms of constant drying rate, drying time, and chlorophyll content of final dried celery though operational temperature was hardly controlled. The drying temperature was highly dependent on the sunlight intensity. The higher the drying temperature was, the higher the constant drying rate and thus the shorter the drying time was. The constant drying rate of celery leaves in the PV/T solar dryer was approximately 16 times higher and 4 times higher compared to those obtained from oven and vacuum oven at drying temperature of about 49°C. The relatively high constant drying rate combined with short drying time was due to the predominant forced convection facilitated heat transfer mechanism created by solar driven blowers besides heat conduction and heat radiation mechanisms. The celery weight reached a constant weight within 87 minutes which was almost half of the required time within oven and vacuum oven without deteriorating the chlorophyll content. The chlorophyll content in PV/T solar dried celery leaves ranged from 4.1–5.7 mg/L which was a bit higher compared with those obtained using oven and vacuum oven. The abundant and renewable solar energy captured by a PV/T solar dryer seemed quite promising for various drying purposes in an efficient and cheap way.

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References

- [1] PT. Sido Muncul 2015 *Delivering The Vision-Annual Report PT. Sido Muncul, Tbk for the year 2015* (Jakarta: PT. Sido Muncul)
- [2] Saputra O and Fitria T 2016 *Jurnal Majority* **5** 120-5
- [3] Sukohar A and Arisandi R 2016 *Jurnal Majority* **5** 95-100
- [4] Alibas I 2014 *Food Sci. Technol.* **34** 394-401
- [5] Arief U M, Suryanto A and Suryanto S 2014 *Saintekno: Jurnal Sains dan Teknologi* **12** 171-81
- [6] Soebiantoro F A, Tarigan E, Hwa L, Halim V P and Sapei L 2018 *Pertanika J. Sci. Technol.* **26** 1 265-74
- [7] Tyagi V V, Kaushik S C and Tyagi S K 2012 *Renewable Sustainable Energy Rev.* **16** 1383–98
- [8] Noro M, Lazzarin R and Bagarella G 2016 *Energy Procedia* **101** 496-503
- [9] Ellabban O, Abu-Rub H, and Blaabjerg F 2014 *Renewable Sustainable Energy Rev.* **39** 748-64
- [10] Geankoplis C J 2003 *Transport Process and Separation Process Principles 4th ed* (New Jersey: Prentice Hall) pp 559-80
- [11] Wintermans J F G M and De Mots A S 1965 *Biochim. Biophys. Acta, Biophys. Incl. Photosynth* **109** 448-453
- [12] Novichonok E V, Novichonok A O, Kurbatova J A and Markovskaya E F 2016 *Photosynthetica* **54** 130-7
- [13] Sapei L, Tarigan E, Lie H, Halim V P and Soebiantoro F A 2017 *KnE Life Sciences* **3** 110-17 Knowledge E.

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Preface

Welcome Remarks,
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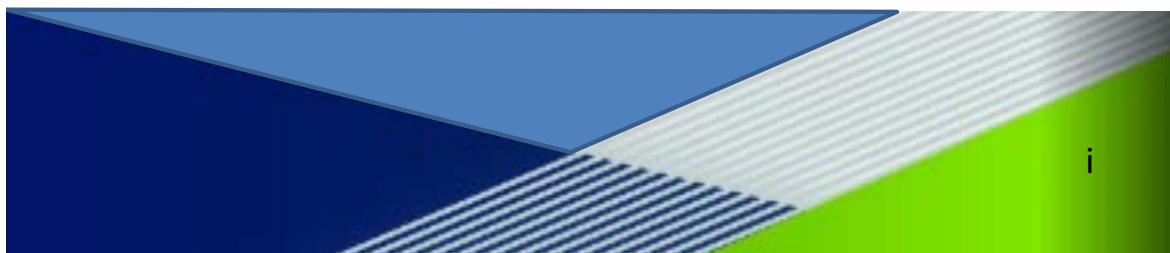
It is a great pleasure to welcome all of you to Bali and to the International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand. The first InCITE has been successfully held in Bali, Indonesia in 2017. We are very delighted to host the second InCITE here in Bali, Indonesia again.

There are more than 75 presentations in this conference. We welcome leading experts not only from Indonesia, but also from different parts of the world. The experts will share the knowledge and experiences in the fields of informatics, technology, science, and engineering. The main theme of this conference is **Enhancing Engineering Innovation Towards A Greener Future** in response to several world challenges including sustainable development, global convergence of information and communications technologies, climate change and global warming as well as the depletion of unrenewable natural resources. We hope this conference will provide you a good opportunity to get to know each other better and consolidate bonds of friendship and mutual trust.

We would like to express our sincere gratitude to the Keynote and Plenary speakers, International Scientific Committee, Steering Committee, and Organising Committee for their huge efforts to make this conference successful.

Thank you all for your support and attendance at InCITE 2019. Please enjoy the conference and Bali !

Asst. Prof. Djuwari, Ph.D.





Preface

Welcome Remarks,
Chair of The Organizing Committee

Welcome to Bali, Indonesia to all delegates and presenters. It is my pleasure and privilege to welcome all of you to the 2nd (second) International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand.

InCITE 2019 has received more than 75 papers to be presented in this conference. All papers represent four following parallel clusters: Green Design and Innovation, Green Manufacturing and Green Processes, Power System and Green Energy Management, and The Role of IT in Innovation Enhancement. Each cluster supports the main theme of the conference, which is **Enhancing Engineering Innovation Towards A Greener Future**. The engineering innovation is the key to increase our awareness in maintaining the sustainable growth and development in the world.

The Organising Committee of InCITE 2019 would like to express our sincere gratitude for the tremendous supports and contributions from many parties. The supports from The Faculty of Engineering of UBAYA, keynote and plenary speakers, our International Scientific Committee, the Steering and Organising Committees are really acknowledged.

The last but not the least, thank you for your supports, enjoy the conference and we hope through this meeting all of you can extend your networks and collaborations.

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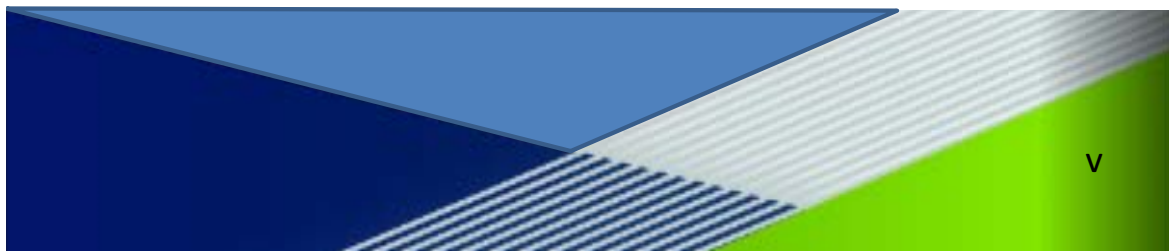
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