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# ON CONNECTIVITY *KV* INDICES OF CERTAIN FAMILIES OF DENDRIMERS

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***ABSTRACT***

*In Chemical Graph Theory, the connectivity indices are applied to measure the chemical characteristics of chemical compounds. In this paper, we propose the product connectivity KV, sum connectivity KV indices of a molecular graph. Also, we compute these connectivity KV indices for certain dendrimers of chemical importance like tetrathiafulvalene dendrimers and POPAM dendrimers.*

***MSC:*** *05C05, 05C07, 05C12, 05C35.*

***Keywords:*** *product connectivity KV index, sum connectivity KV index, dendrimer.*

## 1. INTRODUCTION

A topological index for a graph is used to determine some property of the graph of molecular by a single number. Many topological indices have been considered in Mathematical Chemistry.

Throughout this paper, we consider only finite, connected, undirected graphs without multiple edges and loops. The degree of a vertex $v$, denoted by $d_G(v)$, is the number of edges incident to a vertex $v$. Let $M_G(v)=\prod_{u\in N(v)} d_G(u)$, where $N(v)$ is the set of all adjacent vertices of $v$. We refer [1] for undefined terminologies and notations from graph theory.

Recently, Kulli introduced the first and second *KV* indices, defined as [2]

$$KV_1(G)=\sum_{uv\in E(G)}\left[M_G(u)+M_G(v)\right], \qquad KV_2(G)=\sum_{uv\in E(G)} M_G(u)M_G(v).$$

Very recently, some novel variants of *KV* indices were introduced and studied such as hyper *KV* indices [3], multiplicative *KV* indices [4], square *KV* index [3].

We propose some connectivity *KV* indices of a graph as follows:

The product connectivity *KV* index of a graph $G$ is defined as

$$PKV(G)=\sum_{uv\in E(G)}\frac{1}{\sqrt{M_G(u)M_G(v)}}. \tag{1}$$

The sum connectivity *KV* index of $G$ is defined as

$$SKV(G)=\sum_{uv\in E(G)}\frac{1}{\sqrt{M_G(u)+M_G(v)}}. \tag{2}$$

In recent years, some new connectivity indices have been introduced and studied such as sum connectivity Gourava index [5], sum connectivity index [6], geometric-arithmetic reverse and sum connectivity reverse indices [7], sum connectivity Revan index [8]. Also some connectivity indices were studied, for example, in [9, 10, 11, 12, 13].

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In this paper, some connectivity *KV* indices for tetrathiafulvalene dendrimers and POPAM dendrimers are determined. For denrimers see [14].

## 2. TETRATHIAFULVALENE DENDRIMERS

We consider the family of tetrathiapulvalene dendrimers. This family of dendrimers is denoted by $TD_2[n]$, where $n$ is the steps of growth in this type of dendrimers. The graph of $TD_2[2]$ is presented in Figure 1.

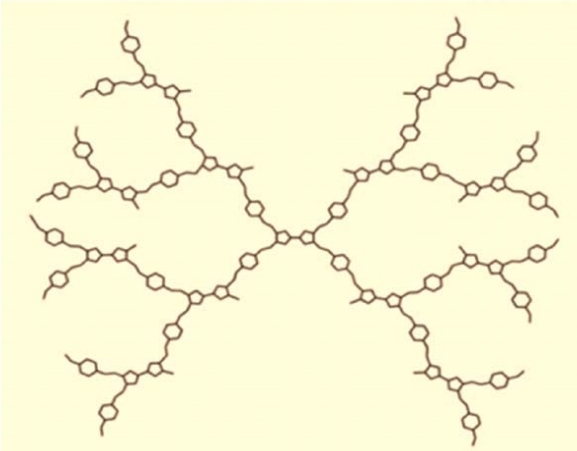

**Figure-1;** Graph of $TD_2[2]$

Let $G = TD_2[n]$. By calculation, we have $|V(G)|=31\times2^{n+2} - 24$, $|E(G)|=32\times2^{n+2} - 85$. The edge partition of $G$ based on the degree product of neighbors of end vertices of each edge is given in Table 1

.

| $M_G(u), M_G(v)\backslash uv \in E(G)$ | Number of edges |
|---|---|
| (2,3) | $2^{n+2}$ |
| (3,6) | $2^{n+2} - 4$ |
| (3,8) | $2^{n+2}$ |
| (6,6) | $7 \times 2^{n+2} - 16$ |
| (6,8) | $11 \times 2^{n+2} - 24$ |
| (6,9) | $2^{n+2} - 4$ |
| (6, 12) | $3 \times 2^{n+2} - 8$ |
| (9,12) | $8 \times 2^{n+2} - 24$ |
| (12, 12) | $2\times2^{n+2} - 5$ |

**Table-1:** Edge partition of $TD_2[n]$

In the following theorem, we compute the product connectivity *KV* index of $TD_2$[n].

**Theorem 1:** The product connectivity *KV* index of tetrathiafulvalene dendrimers is given by

$$PKV\left(TD_2[n]\right)=\left(\frac{11}{6\sqrt{6}}+\frac{5}{6\sqrt{2}}+\frac{49}{12\sqrt{3}}+\frac{4}{3}\right)2^{n+2}-\left(\frac{8}{3\sqrt{2}}+\frac{10}{\sqrt{3}}+\frac{4}{3\sqrt{6}}+\frac{37}{12}\right).$$

**Proof:** By using equation (1) and Table 1, we deduce

$$PKV\,(TD_2[n]) = \sum_{uv\in E(G)}\frac{1}{\sqrt{M_G(u)M_G(v)}}$$

$$=\left(\frac{1}{\sqrt{2\times3}}\right)2^{n+2}+\left(\frac{1}{\sqrt{3\times6}}\right)\left(2^{n+2}-4\right)+\left(\frac{1}{\sqrt{3\times8}}\right)\left(2^{n+2}\right)+\left(\frac{1}{\sqrt{6\times6}}\right)\left(7\times2^{n+2}-16\right)$$

$$+\left(\frac{1}{\sqrt{6\times8}}\right)\left(11\times2^{n+2}-24\right)+\left(\frac{1}{\sqrt{6\times9}}\right)\left(2^{n+2}-4\right)+\left(\frac{1}{\sqrt{6\times12}}\right)\left(3\times2^{n+2}-8\right)$$

$$+\left(\frac{1}{\sqrt{9\times12}}\right)\left(8\times2^{n+2}-24\right)+\left(\frac{1}{\sqrt{12\times12}}\right)\left(2\times2^{n+2}-5\right)$$

$$=\left(\frac{11}{6\sqrt{6}}+\frac{5}{6\sqrt{2}}+\frac{49}{12\sqrt{3}}+\frac{4}{3}\right)2^{n+2}-\left(\frac{8}{3\sqrt{2}}+\frac{10}{\sqrt{3}}+\frac{4}{3\sqrt{6}}+\frac{37}{12}\right).$$

 

In the following theorem, we compute the sum connectivity *KV* index of $TD_2[n]$.

**Theorem 2:** The sum connectivity *KV* index of tetrathiafulvalene dendrimers is given by

$$SKV\left(TD_2[n]\right)=\left(\frac{1}{\sqrt{5}}+\frac{1}{3}+\frac{1}{\sqrt{11}}+\frac{7}{\sqrt{12}}+\frac{11}{\sqrt{14}}+\frac{1}{\sqrt{15}}+\frac{1}{\sqrt{2}}+\frac{8}{\sqrt{21}}+\frac{1}{\sqrt{6}}\right)2^{n+2} -\left(\frac{4}{3}+\frac{8}{\sqrt{3}}+\frac{24}{\sqrt{14}}+\frac{8}{\sqrt{18}}+\frac{24}{\sqrt{21}}+\frac{5}{\sqrt{24}}\right).$$

**Proof:** By using equation (2) and Table 1, we deduce

$$SKV\,(TD_2[n]) = \sum_{uv\in E(G)}\frac{1}{\sqrt{M_G(u)+M_G(v)}}$$

$$=\left(\frac{1}{\sqrt{2+3}}\right)2^{n+2}+\left(\frac{1}{\sqrt{3+6}}\right)(2^{n+2}-4)+\left(\frac{1}{\sqrt{3+8}}\right)(2^{n+2})+\left(\frac{1}{\sqrt{6+6}}\right)(7\times 2^{n+2}-16)$$
$$+\left(\frac{1}{\sqrt{6\times 8}}\right)(11\times 2^{n+2}-24)+\left(\frac{1}{\sqrt{6\times 9}}\right)(2^{n+2}-4)+\left(\frac{1}{\sqrt{6\times 12}}\right)(3\times 2^{n+2}-8)$$
$$+\left(\frac{1}{\sqrt{9+12}}\right)(8\times 2^{n+2}-24)+\left(\frac{1}{\sqrt{12+12}}\right)(2\times 2^{n+2}-5)$$
$$=\left(\frac{1}{\sqrt{5}}+\frac{1}{3}+\frac{1}{\sqrt{11}}+\frac{7}{\sqrt{12}}+\frac{11}{\sqrt{14}}+\frac{1}{\sqrt{15}}+\frac{1}{\sqrt{2}}+\frac{8}{\sqrt{21}}+\frac{1}{\sqrt{6}}\right)2^{n+2} -\left(\frac{4}{3}+\frac{8}{\sqrt{3}}+\frac{24}{\sqrt{14}}+\frac{8}{\sqrt{18}}+\frac{24}{\sqrt{21}}+\frac{5}{\sqrt{24}}\right).$$

## 3. POPAM DENDRIMERS

We consider the family of POPAM dendrimers which is symbolized by $POD_2[n]$. The graph of $POD_2[2]$ is depicted in Figure 2.

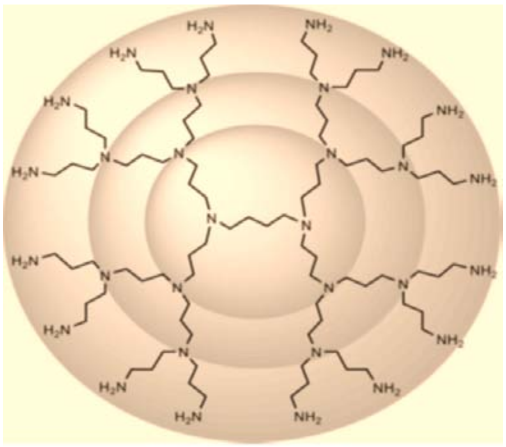


**Figure-2:** Graph of $POD_2[2]$

Let G = $POD_2[n]$. By calculation, we obtain $|V(G)|=2^{n+5}-10$ and $|E(G)|=2^{n+5}-11$. The edge partition of $POD_2[n]$ based on the degree product of neighbors of end vertices of each edge in given in Table 2.

| $M_G(u), M_G(v) \setminus uv \in E(G)$ | (2,2) | (2, 4) | (4, 4) | (4, 6) | (6, 8) |
|---|---|---|---|---|---|
| Number of edges | $2^{n+2}$ | $2^{n+2}$ | 1 | $3 \times 2^{n+2}-6$ | $3 \times 2^{n+2}-6$ |

**Table-2:** Edge partition of $POD_2[n]$

In the following theorem, we compute the product connectivity *KV* index of $POD_2[n]$.

**Theorem 3:** The product connectivity *KV* index of *POPAM* dendrimers is given by

$$PKV\left(POD_2[n]\right)=\left(\frac{1}{2}+\frac{1}{2\sqrt{2}}+\frac{3}{2\sqrt{6}}+\frac{3}{4\sqrt{3}}\right)2^{n+2}-\left(\frac{1}{4}-\frac{6}{\sqrt{6}}-\frac{3}{2\sqrt{3}}\right).$$

**Proof:** By using equation (1) and Table 2, we derive

$$PKV\,(POD_2[n]) = \sum_{uv\in E(G)} \frac{1}{\sqrt{M_G(u)M_G(v)}}$$

$$=\left(\frac{1}{\sqrt{2\times 2}}\right)2^{n+2} + \left(\frac{1}{\sqrt{2\times 4}}\right)2^{n+2} + \left(\frac{1}{\sqrt{4\times 4}}\right) + \left(\frac{1}{\sqrt{4\times 6}}\right)\left(3\times 2^{n+2}-6\right) + \left(\frac{1}{\sqrt{6\times 8}}\right)\left(3\times 2^{n+2}-6\right)$$

$$=\left(\frac{1}{2}+\frac{1}{2\sqrt{2}}+\frac{3}{2\sqrt{6}}+\frac{3}{4\sqrt{3}}\right)2^{n+2} - \left(\frac{1}{4}+\frac{6}{\sqrt{6}}-\frac{3}{2\sqrt{3}}\right).$$

In the following theorem, we compute the sum connectivity *KV* index of $POD_2[n]$.

**Theorem 4:** The sum connectivity *KV* Index of POPAM denderimers is given by

$$SKV\left(POD_2\,[n]\right) = \left(\frac{1}{2}+\frac{1}{\sqrt{6}}+\frac{3}{\sqrt{10}}+\frac{3}{\sqrt{14}}\right)2^{n+2} - \left(\frac{1}{\sqrt{8}}-\frac{6}{\sqrt{10}}-\frac{6}{\sqrt{14}}\right).$$

**Proof:** From equation (2) and Table 2, we derive

$$SKV\,(POD_2[n]) = \sum_{uv\in E(G)} \frac{1}{\sqrt{M_G(u)+M_G(v)}}$$

$$=\left(\frac{1}{\sqrt{2+2}}\right)2^{n+2} + \left(\frac{1}{\sqrt{2+4}}\right)2^{n+2} + \left(\frac{1}{\sqrt{4+4}}\right) + \left(\frac{1}{\sqrt{4\times 6}}\right)\left(3\times 2^{n+2}-6\right) + \left(\frac{1}{\sqrt{6+8}}\right)\left(3\times 2^{n+2}-6\right)$$

$$=\left(\frac{1}{2}+\frac{1}{\sqrt{6}}+\frac{3}{\sqrt{10}}+\frac{3}{\sqrt{14}}\right)2^{n+2} + \left(\frac{1}{\sqrt{8}}-\frac{6}{\sqrt{10}}-\frac{6}{\sqrt{14}}\right).$$

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