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Valency Based Topological Indices of Starphene Graph

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Abstract: The local graph parameter is valency which is defined for each vertex as the number associated with other vertices in a graph just like for an atom in a molecule. The ve-degree and ev-degree of a molecular structure is the wealth of information that it contains about degree-based graph invariants. It gives good results about topological indices. In this paper, we compute ve-degree, ev degree and topological indices of the startphone graph.

MSC: 05C92.

Keywords: Topological indices, ev degree, ve degree, starphene graph.

1. Introduction

Mathematical chemistry is the part of hypothetical science that examines molecular construction by numerical techniques without essentially referring to quantum mechanics. Molecular descriptors a critical part of numerical science particularly in QSPR/QSAR examination. A synthetic construction can be addressed by utilizing graph theory where vertices signify particles and edges indicate substances arithmetic, science and graph theory and solve issues emerging in science numerical [6, 7, 9].

Graph is the set $(V(G), E(G))$, where $V(G)$ is the nodes and $E(G)$ is edges of G. We denote the degree of vertex v by d_v.There are few degree-based records acquainted with testing the properties of the compound starphene. We calculate some degree-based topological indices of starphene graph by using ve degree and ev degree [2, 5], for more information about topological indices and its application see [10–14, 14–19].

A graph is associated assuming there is an association between any sets of vertices. A topological graph index additionally called an atomic descriptor is a numerical equation. From this index, it is feasible to dissect numerical qualities and further examine a few physicochemical properties of a particle. However, it is an effective technique in staying away from costly and tedious research facility tests. These days, there are various topological indices that are valuable for some applied in science. They can be characterized by the primary properties of the graph utilized for their estimation. As a matter of fact, topological indices are numeric amounts that educate us regarding the entire design of the diagram. The topological indices are valuable for the expectation of physicochemical properties and the bioactivity of the synthetic mixtures. [1, 4, 8]. The following tables defines the some important degree-based topological indices.

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Ev-degree Zagreb index	$M^{ev}[St(G)] = \sum\limits_{uv\in E(G)} deg_{ev}e^2$
The first ve-degree Zagreb alpha index	$M_1^{\alpha ve}[St(G)] = \sum\limits_{v\in E(G)} deg_{ve}v^2$
The first ve-degree Zagreb beta index	$M_1^{\beta ve}[St(G)]= \sum\limits_{uv\in E(G)} (deg_{ve}(u) + deg_{ve}(v))$
The second ve-degree Zagreb index	$M_2^{ve}[St(G)] = \sum\limits_{uv\in E(G)} (deg_{ve}udeg_{ve}v)$
Ve-degree Randic index	$R^{ve}[St(G)] = \sum\limits_{uv\in E(G)} (deg_{ve}(u)deg_{ve}(v))^{-1/2}$
Ev-degree Randic index	$R^{ev}[St(G)] = \sum\limits_{e\in E(G)} (deg_{ev}(e)^{-1/2}$
Ve-degree atom-bond connectivity index	$ABC^{ve}[St(G)] = \sum\limits_{uv\in E(G)} \sqrt{\frac{deg_{ve}(u)+deg_v-2}{deg_{ve}(u)\times deg_{ve}(v)}}$
Ve-degree geometric-arithmetic index	$GA^{ve}[St(G)] = \sum\limits_{uv\in E(G)} \frac{2\sqrt{degve(u)\times deg_{ve}(v)}}{deg_{ve}(u)+deg_{ve}(v)}$
Ve-degree harmonic index	$H^{ve}[St(G)] = \sum\limits_{uv\in E(G)} \frac{2}{deg_{ve}(u)+deg_{ve}(v)}$
Ve-degree sum-connectivity index	$X^{ve}[St(G)] = \sum\limits_{uv\in E(G)} (deg_{ve}(u) + deg_{ve}(v))^{-1/2}$

Starphene is the basic building block for the miniaturization of different especially organic electronic devices. It plays a vital role in various gates and electronic devices like Nor and NAND gate.Starphene is a two-dimensional structure. Starphene is from PHA. It has three acene arms we denoted as (p, q, r) arms on a centred benzene ring. We represent the starphene structure or network in our whole work using St(p, q, r). Starphene has $4(p + q + r) - 6$ the total number of vertex and $5(p + q + r) - 9$ are the total number of edge. Given below are the vertex and edge sets of the corresponding graph of St. These calculations give the information about the underlying topology of Starphene(St). In this paper, we focus on the structures of a family of starphene and they are also known as polycyclic aromatic hydrocarbons (PAH).

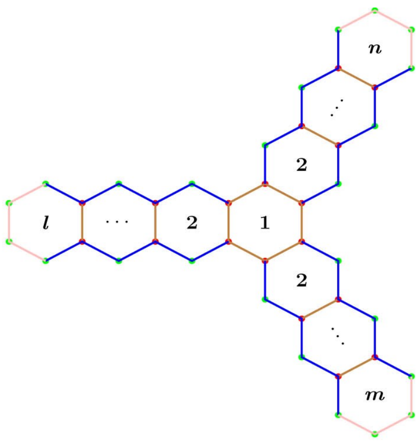

Figure 1. **Starphene structure**

1.1. Some fundamental results of Starphene(St)

Number of vertices	Degree	Ve-degree
6	2	4
6	2	5
6(p+q+r)-12	2	6
6(p+q+r)-12	3	7
6	3	8

Table 1. **The ve-degree of the vertices of the starphene(St)**

Number of edges	Degree of its end vertices	Ve-degree of its end vertices
3	(2,2)	(4,4)
6	(2,2)	(4,5)
6	(2,3)	(5,7)
4(p+q+r)-30	(2,3)	(6,7)
(p+q+r)-6	(3,3)	(7,7)
6	(2,3)	(6,8)
6	(3,3)	(8,8)

Table 2. **The ve-degree of the end vertex of edges of the starphene(St)**

Number of edges	Degree of its end vertices	Ev-degree
9	(2,2)	4
12p-6	(2,3)	5
3p+3	(3,3)	6

Table 3. **The ev-degree of the edges(loops) of the starphene(St)**

2. Main Result

Theorem 2.1. *Let $G = St$ be the starphene graph on the vertex set $[n]$. The valency based topological indies of G are the following:*

(1). $M^{ev}(G) = 102 + 408p$

(2). $M^{\alpha ve}(G) = -390 + 510(p + q + r)$

(3). $M^{\beta ve}(G) = -144 + 66(p + q + r)$

(4). $M^{ve}(G) = -504 + 217(p + q + r)$

(5). $R^{ve}(G) = \frac{6}{4} + \frac{6}{\sqrt{5}} + \frac{6}{\sqrt{35}} + \frac{6}{4\sqrt{3}} + \frac{4(p+q+r)-30}{\sqrt{42}} + \frac{p+q+r-6}{7}$

(6). $R^{ev}(G) = \frac{9}{2} + \frac{12p-6}{\sqrt{6}} + \frac{3p+3}{\sqrt{6}}$

(7). $ABC^{ve}(G) = 3 + \frac{3\sqrt{6}}{4} + \frac{3\sqrt{7}}{\sqrt{5}} + \frac{6\sqrt{2}}{\sqrt{7}} + \frac{3\sqrt{14}}{4} + \frac{(4p+4q+4r-30)\sqrt{11}}{\sqrt{42}} + \frac{(2p+2q+2r-12)\sqrt{3}}{7}$

(8). $GA^{ve}(G) = 9 + \sqrt{35} + (p+q+r-6) + \frac{8\sqrt{5}}{3} + \frac{24\sqrt{3}}{7} + \frac{[8(p+q+r-60]\sqrt{42}}{13}$

(9). $H^{ve}(G) = \frac{805}{182} + \frac{(p+q+r-6)}{7} + \frac{8(p+q+r)-60}{13}$

(10). $X^{ve}(G) = \frac{7}{2} + \frac{3}{\sqrt{3}} + \frac{3}{2\sqrt{2}} + \frac{6}{\sqrt{14}} + \frac{(p+q+r-6)}{\sqrt{14}} + \frac{4(p+q+r)-30}{\sqrt{13}}$

Proof.

(1). **ev-degree Zagreb index**

$$M^{ev}(G) = 9 \times 4^2 + (12p-6) \times 5^2 + (3p+3) \times 6^2$$
$$M^{ev}(G) = 9 \times 16 + (12p-6) \times 25 + (3p+3) \times 36$$
$$M^{ev}(G) = 144 + 300 - 150 + 108p + 108$$
$$M^{ev}(G) = 102 + 408p$$

(2). **The first ve-degree Zegrab alpha index**

$$M^{\alpha ve}(G) = 6 \times 4^2 + 6 \times 5^2 + [6(p+q+r) - 12] \times 6^2 + [6(p+q+r) - 12] \times 7^2 + 6 \times 8^2$$
$$M^{\alpha ve}(G) = 96 + 150 + 96p + 6q + 6r - 120 \times 36 + (6p + 6q + 6r - 12) \times 49 + 384$$
$$M^{\alpha ve}(G) = 630 + 216p + 216q + 216r - 432 + 294p + 294q + 294r - 588$$
$$M^{\alpha ve}(G) = -390 + 510p + 510q + 510r$$
$$M^{\alpha ve}(G) = -390 + 510(p+q+r)$$

(3). **The first ve-degree Zagreb beta index**

$$M^{\beta ve}(G) = 3(4+4) + 6(4+5) + 6(5+7) + [4(p+q+r) - 30](6+7) + (p+q+r-6)(7+7) + 6(6+8) + 6(8+8)$$
$$M^{\beta ve}(G) = 24 + 54 + 72 + 13(4p + 4q + 4r - 30) + 14(p+q+r-6) + 84 + 96$$
$$M^{\beta ve}(G) = 330 + 52p + 52q + 52r - 390 + 14p + 14q + 14r - 84$$
$$M^{\beta ve}(G) = -144 + 66p + 66q + 66r$$
$$M^{\beta ve}(G) = -144 + 66(p+q+r)$$

(4). **The second ve-degree Zareb index**

$$M^{ve}(G) = 3(4 \times 4) + 6(4 \times 5) + 6(5 \times 7) + [4(p+q+r) - 30](6 \times 7) + (p+q+rn-6)(7 \times 7) + 6(6 \times 8) + (8 \times 8)$$
$$M^{ve}(G) = 48 + 120 + 210 + 42(4p + 4q + 4r - 30) + (p+q+r-6)49 + 288 + 384$$
$$M^{ve}(G) = 1050 + 168p + 18q + 168r - 1260 + 49p + 49q + 49r - 294$$
$$M^{ve}(G) = -504 + 217p + 217q + 217r$$
$$M^{ve}(G) = -504 + 217(p+q+r)$$

(5). **ve-degree Randic index**

$$
\begin{aligned}
R^{ve}(G) &= \frac{3}{\sqrt{4\times 4}} + \frac{6}{\sqrt{4\times 5}} + \frac{6}{\sqrt{5\times 7}} + \frac{4(p+q+r)-30}{\sqrt{6\times 7}} + \frac{(p+q+r-6)}{\sqrt{7\times 7}} + \frac{6}{\sqrt{6\times 8}} + \frac{6}{\sqrt{8\times 8}}\\
R^{ve}(G) &= \frac{3}{4} + \frac{6}{2\sqrt{5}} + \frac{6}{\sqrt{35}} + \frac{4(p+q+r)-30}{\sqrt{42}} + \frac{(p+q+r-6)}{7} + \frac{6}{\sqrt{48}} + \frac{6}{8}\\
R^{ve}(G) &= \frac{3}{4} + \frac{3}{4} + \frac{3}{\sqrt{5}} + \frac{6}{\sqrt{35}} + \frac{6}{\sqrt{16\times 3}} + \frac{(4p+4q+4r-30)}{\sqrt{42}} + \frac{(p+q+r-6)}{7}\\
R^{ve}(G) &= \frac{6}{4} + \frac{3}{\sqrt{5}} + \frac{6}{\sqrt{35}} + \frac{6}{4\sqrt{3}} + \frac{(4p+4q+4r-30)}{\sqrt{42}} + \frac{(p+q+r-6)}{7}\\
R^{ve}(G) &= \frac{6}{4} + \frac{6}{\sqrt{5}} + \frac{6}{\sqrt{35}} + \frac{6}{4\sqrt{3}} + \frac{4(p+q+r)-30}{\sqrt{42}} + \frac{p+q+r-6}{7}.
\end{aligned}
$$

(6). **ev-degree Randic index**

$$
\begin{aligned}
R^{ev}(G) &= \frac{9}{\sqrt{4}} + \frac{12p-6}{\sqrt{5}} + \frac{3p+3}{\sqrt{6}}\\
R^{ev}(G) &= \frac{9}{2} + \frac{12p-6}{\sqrt{6}} + \frac{3p+3}{\sqrt{6}}
\end{aligned}
$$

(7). **ve-degree atom-bond conenctivity index** [3]

$$
\begin{aligned}
ABC^{ve}(G) &= 3\sqrt{\frac{4+4-2}{4\times 4}} + 6\sqrt{\frac{4+5-2}{4\times}} + 6\sqrt{\frac{4+7-2}{4\times 7}} + [4(p+q+r)-30]\sqrt{\frac{6+7-2}{6\times 7}}\\
&\quad + (p+q+r-6)\sqrt{\frac{7+7-2}{7\times 7}} + 6\sqrt{\frac{6+8-2}{6\times 8}} + 6\sqrt{\frac{8+8-2}{8\times 8}}\\
ABC^{ve}(G) &= \frac{3\sqrt{6}}{4} + \frac{6}{2}\sqrt{\frac{7}{5}} + 6\sqrt{\frac{10}{35}} + (4p+4q+4r-30)\sqrt{\frac{11}{42}} + (p+q+r-6)\sqrt{\frac{12}{49}} + 6\sqrt{\frac{12}{48}} + 6\sqrt{\frac{14}{64}}\\
ABC^{ve}(G) &= \frac{3\sqrt{6}}{4} + \frac{3\sqrt{7}}{\sqrt{5}} + \frac{6\sqrt{10}}{\sqrt{35}} + 6\sqrt{\frac{1}{4}} + \frac{6\sqrt{14}}{8} + (4p+4q+4r-30)\frac{11}{42} + (p+q+r-6)\frac{2\sqrt{3}}{7}\\
ABC^{ve}(G) &= \frac{6}{2} + \frac{3\sqrt{6}}{4} + \frac{3\sqrt{14}}{4} + \frac{3\sqrt{7}}{\sqrt{5}} + \frac{6\sqrt{10}}{\sqrt{35}} + \frac{(4p+4q+4r-30)\sqrt{11}}{\sqrt{42}} + \frac{(2p+2q+2r-12)\sqrt{3}}{7}\\
ABC^{ve}(G) &= 3 + \frac{3\sqrt{6}}{4} + \frac{3\sqrt{7}}{\sqrt{5}} + \frac{6\sqrt{2}}{\sqrt{7}} + \frac{3\sqrt{14}}{4} + \frac{(4p+4q+4r-30)\sqrt{11}}{\sqrt{42}} + \frac{(2p+2q+2r-12)\sqrt{3}}{7}
\end{aligned}
$$

(8). **ve-degree geometric-arithmetic index**

$$
\begin{aligned}
GA^{ve}(G) &= \frac{3\times 2\sqrt{4\times 4}}{4+4} + \frac{6\times 2\sqrt{4\times 5}}{4+5} + \frac{6\times 2\sqrt{5\times 7}}{5+7} + \frac{2\times[4(p+q+r)-30]\sqrt{6\times 7}}{6+7}\\
&\quad + \frac{2(p+q+r-6)\sqrt{7\times 7}}{7+7} + \frac{6\times 2\sqrt{6\times 8}}{6+8} + \frac{6\times 2\sqrt{8\times 8}}{8+8}\\
GA^{ve}(G) &= \frac{6\times 4}{8} + \frac{12\times 2\sqrt{5}}{9} + \frac{12\sqrt{35}}{12} + \frac{[8(p+q+r)-60]\sqrt{42}}{13} + \frac{2(p+q+r-6)7}{14} + \frac{12\sqrt{48}}{14} + \frac{12\times 8}{16}\\
GA^{ve}(G) &= \frac{24}{8} + \frac{24\sqrt{5}}{9} + \sqrt{35} + \frac{12}{6} + \frac{6\times 4\sqrt{3}}{7} + \frac{[8(p+q+r)-60]\sqrt{42}}{13} + (p+q+r-6)\\
GA^{ve}(G) &= 3 + 6 + \sqrt{35} + \frac{8\sqrt{5}}{3} + \frac{24\sqrt{3}}{7} + (p+q+r-6) + \frac{[8(p+q+r)-60]\sqrt{42}}{13}\\
GA^{ve}(G) &= 9 + \sqrt{35} + (p+q+r-6) + \frac{8\sqrt{5}}{3} + \frac{24\sqrt{3}}{7} + \frac{[8(p+q+r-60]\sqrt{42}}{13}
\end{aligned}
$$

(9). **ve-degree harmoic index**

$$
\begin{aligned}
H^{ve}(G) &= \frac{3\times 2}{4+4} + \frac{6\times 2}{4+5} + \frac{6\times 2}{5+7} + \frac{2[4(p+q+r)-30]}{6+7} + \frac{2[p+q+r-6]}{7+7} + \frac{6\times 2}{6+8} + \frac{6\times 2}{8+8}\\
H^{ve}(G) &= \frac{6}{8} + \frac{12}{9} + \frac{12}{12} + \frac{12}{14} + \frac{12}{16} + \frac{2[p+q+r-6]}{14} + \frac{2[4(p+q+r)-30]}{13}
\end{aligned}
$$

$$H^{ve}(G) = \frac{3}{4} + \frac{4}{3} + 1 + \frac{6}{7} + \frac{3}{4} + \frac{[p+q+r-6]}{7} + \frac{[8(p+q+r)-30]}{13}$$
$$H^{ve}(G) = 1 + \frac{6}{4} + \frac{4}{3} + \frac{6}{3} + \frac{[p+q+r-6]}{7} + \frac{[8(p+q+r)-30]}{13}$$
$$H^{ve}(G) = 1 + \frac{3}{2} + \frac{10}{3} + \frac{[p+q+r-6]}{7} + \frac{[8(p+q+r)-30]}{13}$$
$$H^{ve}(G) = \frac{6+9+10}{6} + \frac{[p+q+r-6]}{7} + \frac{[8(p+q+r)-30]}{13}$$
$$H^{ve}(G) = \frac{35}{6} + \frac{(p+q+r-6)}{7} + \frac{8(p+q+r)-60}{13}$$

(10). **ve-degree sum-connectivity index**

$$X^{ve}(G) = \frac{3}{\sqrt{4+4}} + \frac{6}{\sqrt{4+5}} + \frac{6}{\sqrt{5+7}} + \frac{4(p+q+r)-30}{\sqrt{6+7}} + \frac{p+q+r-6}{\sqrt{7+7}} + \frac{6}{\sqrt{6+8}} + \frac{6}{\sqrt{8+8}}$$
$$X^{ve}(G) = \frac{3}{\sqrt{8}} + \frac{6}{\sqrt{9}} + \frac{6}{\sqrt{12}} + \frac{4(p+q+r)-30}{\sqrt{13}} + \frac{p+q+r-6}{\sqrt{14}} + \frac{6}{\sqrt{14}} + \frac{6}{\sqrt{16}}$$
$$X^{ve}(G) = \frac{3}{2\sqrt{2}} + \frac{6}{3} + \frac{6}{2\sqrt{3}} + \frac{6}{4} + \frac{6}{\sqrt{14}} + \frac{(p+q+r-6)}{\sqrt{14}} + \frac{4(p+q+r)-30}{\sqrt{13}}$$
$$X^{ve}(G) = 2 + \frac{3}{2} + \frac{3}{\sqrt{3}} + \frac{3}{2\sqrt{2}} + \frac{6}{\sqrt{14}} + \frac{(p+q+r-6)}{\sqrt{14}} + \frac{4(p+q+r)-30}{\sqrt{13}}$$
$$X^{ve}(G) = \frac{4+3}{2} + \sqrt{3} + \frac{3}{2\sqrt{2}} + \frac{6}{\sqrt{14}} + \frac{(p+q+r-6)}{\sqrt{14}} + \frac{4(p+q+r)-30}{\sqrt{13}}$$
$$X^{ve}(G) = \frac{7}{2} + \sqrt{3} + \frac{3}{2\sqrt{2}} + \frac{6}{\sqrt{14}} + \frac{(p+q+r-6)}{\sqrt{14}} + \frac{4(p+q+r)-30}{\sqrt{13}}$$

□

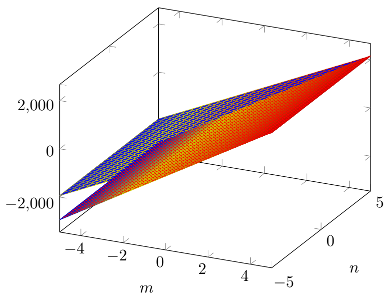

Figure 2. **Graph of Zagrab index and Zagrab alpha index**

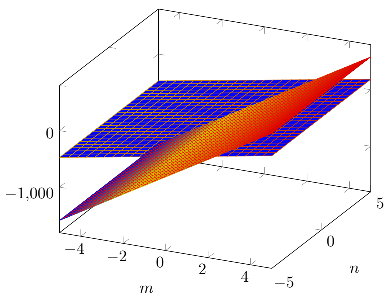

Figure 3. **Graph of First beta Zagrab and second Zagrab index**

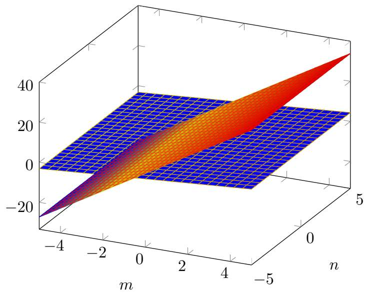

Figure 4. **Graph of ve and ev Randic index**

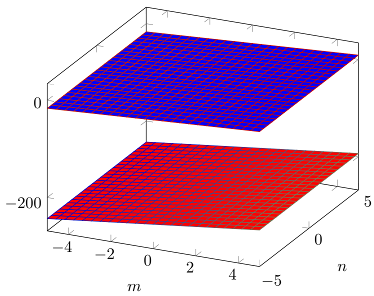

Figure 5. **Graph of atomic bond connectivity and geometric arithmetic index**

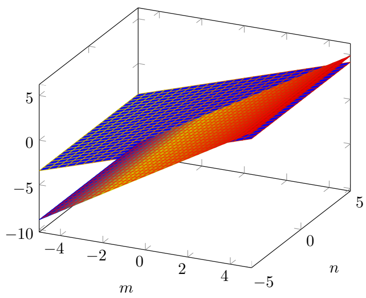

Figure 6. **Graph of Hormonic and sum-connectivity index**

3. Conclusion

Due to speedy development in chemistry a large number of compounds are invented day by day so there is a need to take experiments to test the properties of new chemical compounds. But the developing countries have not able to afford the relevant equipment, human resources and reagents due to shortage of funds. Topological indices support us to reduce the number of experiments. Because are based on molecular structure of compound and computed easily. The results calculated in this work have the bright application in chemistry.

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