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Phthalazin-1(2H)-one–picric acid (1/1)

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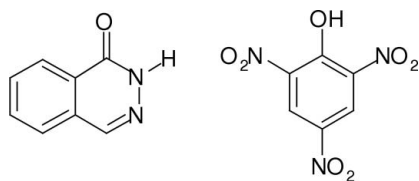
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 Key indicators: single-crystal X-ray study; $T = 173$ K; mean $\sigma(\text{C}-\text{C}) = 0.002$ Å; R factor = 0.034; wR factor = 0.091; data-to-parameter ratio = 11.1.

The geometric parameters of the title compound, $\text{C}_8\text{H}_6\text{N}_2\text{O} \cdot \text{C}_6\text{H}_3\text{N}_3\text{O}_7$, are in the usual ranges. The three nitro groups are almost coplanar with the aromatic picrate ring [dihedral angles 10.2 (2)°, 7.62 (16) and 8.08 (17)°]. The molecular conformation of the picric acid is stabilized by an intramolecular $\text{O}-\text{H} \cdots \text{O}$ hydrogen bond. The phthalazin-1(2H)-one molecules are connected *via* $\text{N}-\text{H} \cdots \text{O}$ hydrogen bonds, forming centrosymmetric dimers.

Related literature

For related literature, see: Büyükgüngör, Odabaşoğlu, Narayana, *et al.* (2007); Büyükgüngör, Odabaşoğlu, Vijesh & Yathirajan (2007); Balogh-Hergovich *et al.* (1997); Butcher *et al.* (2007); Cheng *et al.* (1999); Coates (1999); Harrison *et al.* (2007); Li *et al.* (2006); Porter (1979); Sarojini *et al.* (2007); Shubin *et al.* (2004); Yatani *et al.* (2001).



Experimental

Crystal data

 $\text{C}_8\text{H}_6\text{N}_2\text{O} \cdot \text{C}_6\text{H}_3\text{N}_3\text{O}_7$
 $M_r = 375.26$
 Monoclinic, $P2_1/n$
 $a = 6.9277$ (4) Å
 $b = 9.2087$ (8) Å

 $c = 23.6900$ (15) Å
 $\beta = 95.246$ (5)°
 $V = 1504.98$ (18) Å³
 $Z = 4$
 Mo $K\alpha$ radiation

 $\mu = 0.14$ mm⁻¹
 $T = 173$ (2) K

 $0.27 \times 0.25 \times 0.24$ mm

Data collection

 Stoe IPDSII diffractometer
 Absorption correction: none
 18938 measured reflections

 2819 independent reflections
 2384 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.043$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.034$
 $wR(F^2) = 0.091$
 $S = 1.02$
 2819 reflections
 253 parameters

 H atoms treated by a mixture of independent and constrained refinement
 $\Delta\rho_{\text{max}} = 0.22$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.18$ e Å⁻³

 Table 1
 Hydrogen-bond geometry (Å, °).

| $D-H \cdots A$ | $D-H$ | $H \cdots A$ | $D \cdots A$ | $D-H \cdots A$ |
|---|----------|--------------|--------------|----------------|
| $\text{N1}-\text{H1} \cdots \text{O1}^i$ | 0.94 (2) | 1.89 (2) | 2.8252 (16) | 175.2 (17) |
| $\text{O11}-\text{H11} \cdots \text{O17}$ | 0.90 (3) | 1.79 (3) | 2.5819 (16) | 146 (2) |

 Symmetry code: (i) $-x + 1, -y + 1, -z + 1$.

Data collection: *X-AREA* (Stoe & Cie, 2001); cell refinement: *X-AREA*; data reduction: *X-AREA*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1990); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXL97*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: AT2514).

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supporting information

Acta Cryst. (2008). E64, o119 [https://doi.org/10.1107/S1600536807063362]

Phthalazin-1(2*H*)-one–picric acid (1/1)

H. S. Yathirajan, B. Narayana, M. T. Swamy, B. K. Sarojini and Michael Bolte

S1. Comment

Phthalazines, also called benzo-orthodiazines or benzopyridazines, are a group of heterocyclic compounds isomeric with the cinnolines. The practical interest upon phthalazine derivatives is based on their widespread applications (Coates, 1999). Phthalazines, like others members of the isomeric diazine series, have found wide applications as therapeutic agents (Porter, 1979). Phthalazines are also commonly used as ligands in transition metal catalysis (Balogh-Hergovich *et al.*, 1997 & Yatani *et al.*, 2001), as chemiluminescent materials (Shubin *et al.*, 2004) and for optical applications (Cheng *et al.*, 1999). 2-Substituted-8-(4,6-dimethoxypyrimidin-2-yloxy)-4-methylphthalazin-1-one derivatives are used as herbicides (Li *et al.*, 2006). Structures of phthalazin-1(2*H*)-one (

Büyükgüngör, Odabaşoğlu, Narayana, Vijesh & Yathirajan, 2007), (1*Z*)-phthalazin-1(2*H*)-one isopropylidenehydrazone (Büyükgüngör, Odabaşoğlu, Vijesh & Yathirajan, 2007), 4-methoxybenzaldehyde (phthalazin-1-ylidene)hydrazone (Butcher *et al.*, 2007) have been published. A similar structure was observed with phenothiazine-picric acid (Harrison *et al.*, 2007). In continuation to our studies on the structures of picrates (Sarojini *et al.*, 2007), a new cocrystal of phthalazin-1(2*H*)-one with picric acid was obtained when we prepared the picrate using the usual procedure and its crystal structure is reported.

Geometric parameters of the title compound are in the usual ranges. The three nitrogroups are almost coplanar with the aromatic picrate ring [dihedral angles 10.2 (2)°, 7.62 (16) and 8.08 (17)°]. The molecular conformation of the picric acid is stabilized by an intramolecular O—H···O hydrogen bond. The phthalazin-1(2*H*)-one molecules are connected *via* N—H···O hydrogen bonds to form centrosymmetric dimers.

S2. Experimental

Phthalazin-1(2*H*)-one (1.46 g, 0.01 mol) was dissolved in 25 ml of ethanol. Picric acid (2.29 g, 0.01 mol) was dissolved in 10 ml of water. Both the solutions were mixed and to this 5 ml of 5 *M* HCl was added and stirred for few minutes. The precipitate formed was filtered, dried and *x*-ray quality crystals were obtained by slow evaporation from absolute ethanol [m. p.: 403–405 K]. Composition: Found (Calculated): C 44.72 (44.81), H 2.39 (2.42), N 18.60% (18.66%).

S3. Refinement

H atoms were found in a difference map, but those bonded to C were geometrically positioned and refined with fixed individual displacement parameters [$U_{\text{iso}}(\text{H}) = 1.2 U_{\text{eq}}(\text{C})$] using a riding model with C—H = 0.95 Å. H atoms bonded to N and O were freely refined.

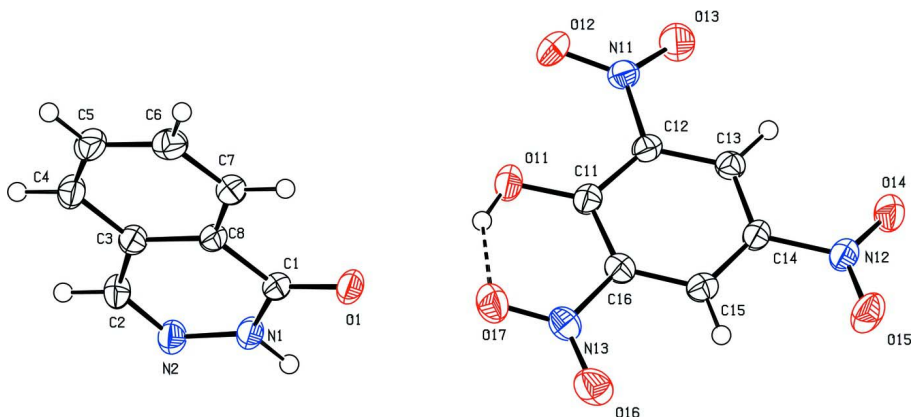


Figure 1

Perspective view of the title compound with the atom numbering; displacement ellipsoids are at the 50% probability level. The intramolecular hydrogen bond is shown as a dashed line.

Phthalazin-1(2H)-one-picric acid (1/1)

Crystal data

$C_6H_3N_3O_7 \cdot C_8H_6N_2O$

$M_r = 375.26$

Monoclinic, $P2_1/n$

Hall symbol: $-P 2_1 n$

$a = 6.9277$ (4) Å

$b = 9.2087$ (8) Å

$c = 23.6900$ (15) Å

$\beta = 95.246$ (5)°

$V = 1504.98$ (18) Å³

$Z = 4$

$F(000) = 768$

$D_x = 1.656$ Mg m⁻³

Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å

Cell parameters from 18866 reflections

$\theta = 3.5$ – 25.7 °

$\mu = 0.14$ mm⁻¹

$T = 173$ K

Block, yellow

$0.27 \times 0.25 \times 0.24$ mm

Data collection

Stoe IPDSII

diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

ω scans

18938 measured reflections

2819 independent reflections

2384 reflections with $I > 2\sigma(I)$

$R_{int} = 0.043$

$\theta_{max} = 25.6$ °, $\theta_{min} = 3.4$ °

$h = -8 \rightarrow 8$

$k = -11 \rightarrow 11$

$l = -28 \rightarrow 28$

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)] = 0.034$

$wR(F^2) = 0.091$

$S = 1.02$

2819 reflections

253 parameters

0 restraints

Primary atom site location: structure-invariant

direct methods

Secondary atom site location: difference Fourier

map

Hydrogen site location: inferred from neighbouring sites

H atoms treated by a mixture of independent and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.0623P)^2 + 0.1404P]$

where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{max} = 0.001$

$\Delta\rho_{max} = 0.22$ e Å⁻³

$\Delta\rho_{min} = -0.18$ e Å⁻³

Extinction correction: *SHELXL*,

$F_c^* = kF_c[1 + 0.001x F_c^2 \lambda^3 / \sin(2\theta)]^{-1/4}$

Extinction coefficient: 0.0119 (17)

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R -factor wR and goodness of fit S are based on F^2 , conventional R -factors R are based on F , with F set to zero for negative F^2 . The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating R -factors(gt) *etc.* and is not relevant to the choice of reflections for refinement. R -factors based on F^2 are statistically about twice as large as those based on F , and R -factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (\AA^2)

| | <i>x</i> | <i>y</i> | <i>z</i> | $U_{\text{iso}}^*/U_{\text{eq}}$ |
|-----|---------------|--------------|-------------|----------------------------------|
| O1 | 0.66147 (14) | 0.65518 (11) | 0.51988 (4) | 0.0300 (2) |
| N1 | 0.67645 (17) | 0.48688 (13) | 0.45056 (5) | 0.0272 (3) |
| H1 | 0.562 (3) | 0.445 (2) | 0.4613 (8) | 0.044 (5)* |
| N2 | 0.75780 (17) | 0.41599 (13) | 0.40757 (5) | 0.0292 (3) |
| C1 | 0.74820 (18) | 0.60533 (15) | 0.48045 (5) | 0.0240 (3) |
| C2 | 0.9215 (2) | 0.46716 (16) | 0.39350 (6) | 0.0287 (3) |
| H2 | 0.9818 | 0.4186 | 0.3644 | 0.034* |
| C3 | 1.01736 (19) | 0.59266 (15) | 0.41912 (6) | 0.0258 (3) |
| C4 | 1.1946 (2) | 0.64606 (17) | 0.40233 (6) | 0.0303 (3) |
| H4 | 1.2568 | 0.5978 | 0.3735 | 0.036* |
| C5 | 1.2770 (2) | 0.76868 (17) | 0.42798 (6) | 0.0318 (3) |
| H5 | 1.3962 | 0.8044 | 0.4167 | 0.038* |
| C6 | 1.1867 (2) | 0.84098 (16) | 0.47044 (6) | 0.0310 (3) |
| H6 | 1.2441 | 0.9261 | 0.4873 | 0.037* |
| C7 | 1.0148 (2) | 0.78938 (15) | 0.48800 (6) | 0.0271 (3) |
| H7 | 0.9549 | 0.8380 | 0.5172 | 0.033* |
| C8 | 0.92916 (18) | 0.66482 (15) | 0.46255 (5) | 0.0236 (3) |
| C11 | 0.55633 (18) | 0.74695 (14) | 0.68594 (6) | 0.0240 (3) |
| C12 | 0.58222 (18) | 0.69094 (14) | 0.74195 (6) | 0.0235 (3) |
| C13 | 0.44722 (18) | 0.71095 (14) | 0.78092 (6) | 0.0239 (3) |
| H13 | 0.4688 | 0.6721 | 0.8181 | 0.029* |
| C14 | 0.28010 (19) | 0.78865 (14) | 0.76467 (6) | 0.0241 (3) |
| C15 | 0.24542 (19) | 0.84793 (14) | 0.71086 (6) | 0.0249 (3) |
| H15 | 0.1298 | 0.9006 | 0.7003 | 0.030* |
| C16 | 0.38311 (19) | 0.82836 (14) | 0.67310 (6) | 0.0242 (3) |
| N11 | 0.75280 (16) | 0.60220 (13) | 0.76171 (5) | 0.0280 (3) |
| N12 | 0.13440 (16) | 0.80502 (13) | 0.80526 (5) | 0.0279 (3) |
| N13 | 0.34405 (18) | 0.89697 (13) | 0.61722 (5) | 0.0287 (3) |
| O11 | 0.68359 (15) | 0.71926 (12) | 0.64906 (5) | 0.0332 (3) |
| H11 | 0.643 (4) | 0.767 (3) | 0.6170 (11) | 0.075 (7)* |
| O12 | 0.89061 (14) | 0.59522 (13) | 0.73298 (5) | 0.0405 (3) |
| O13 | 0.74780 (16) | 0.53924 (14) | 0.80712 (5) | 0.0434 (3) |
| O14 | 0.15798 (15) | 0.73720 (13) | 0.84986 (4) | 0.0392 (3) |
| O15 | -0.00576 (15) | 0.88503 (13) | 0.79219 (5) | 0.0397 (3) |
| O16 | 0.18568 (17) | 0.95344 (12) | 0.60558 (5) | 0.0410 (3) |

O17 0.47424 (16) 0.89587 (12) 0.58474 (4) 0.0374 (3)

Atomic displacement parameters (Å²)

| | U^{11} | U^{22} | U^{33} | U^{12} | U^{13} | U^{23} |
|-----|------------|------------|------------|-------------|-------------|-------------|
| O1 | 0.0242 (5) | 0.0360 (6) | 0.0314 (5) | -0.0009 (4) | 0.0101 (4) | -0.0075 (4) |
| N1 | 0.0236 (6) | 0.0319 (6) | 0.0271 (6) | -0.0020 (5) | 0.0077 (5) | -0.0047 (5) |
| N2 | 0.0285 (6) | 0.0324 (6) | 0.0277 (6) | 0.0001 (5) | 0.0073 (5) | -0.0043 (5) |
| C1 | 0.0201 (6) | 0.0283 (7) | 0.0237 (6) | 0.0036 (5) | 0.0021 (5) | 0.0005 (5) |
| C2 | 0.0292 (7) | 0.0329 (7) | 0.0250 (7) | 0.0025 (6) | 0.0083 (5) | -0.0028 (6) |
| C3 | 0.0238 (6) | 0.0303 (7) | 0.0234 (7) | 0.0036 (5) | 0.0033 (5) | 0.0041 (5) |
| C4 | 0.0271 (7) | 0.0381 (8) | 0.0270 (7) | 0.0036 (6) | 0.0090 (6) | 0.0049 (6) |
| C5 | 0.0238 (7) | 0.0401 (8) | 0.0322 (8) | -0.0028 (6) | 0.0056 (6) | 0.0082 (6) |
| C6 | 0.0278 (7) | 0.0317 (7) | 0.0329 (8) | -0.0031 (6) | -0.0006 (6) | 0.0037 (6) |
| C7 | 0.0249 (6) | 0.0301 (7) | 0.0262 (7) | 0.0028 (5) | 0.0020 (5) | -0.0007 (5) |
| C8 | 0.0192 (6) | 0.0291 (7) | 0.0226 (6) | 0.0031 (5) | 0.0024 (5) | 0.0030 (5) |
| C11 | 0.0225 (6) | 0.0228 (6) | 0.0271 (7) | -0.0038 (5) | 0.0045 (5) | -0.0047 (5) |
| C12 | 0.0193 (6) | 0.0234 (6) | 0.0275 (7) | -0.0001 (5) | 0.0010 (5) | -0.0035 (5) |
| C13 | 0.0234 (6) | 0.0238 (6) | 0.0242 (7) | -0.0013 (5) | 0.0007 (5) | -0.0018 (5) |
| C14 | 0.0211 (6) | 0.0248 (6) | 0.0269 (7) | -0.0010 (5) | 0.0054 (5) | -0.0035 (5) |
| C15 | 0.0227 (6) | 0.0223 (6) | 0.0292 (7) | 0.0000 (5) | 0.0006 (5) | -0.0024 (5) |
| C16 | 0.0271 (7) | 0.0213 (6) | 0.0240 (7) | -0.0025 (5) | 0.0010 (5) | -0.0009 (5) |
| N11 | 0.0232 (6) | 0.0320 (6) | 0.0282 (6) | 0.0030 (5) | -0.0003 (5) | -0.0058 (5) |
| N12 | 0.0239 (6) | 0.0298 (6) | 0.0306 (6) | 0.0008 (5) | 0.0064 (5) | -0.0022 (5) |
| N13 | 0.0360 (7) | 0.0248 (6) | 0.0250 (6) | -0.0001 (5) | 0.0015 (5) | -0.0017 (5) |
| O11 | 0.0300 (5) | 0.0421 (6) | 0.0291 (6) | 0.0055 (4) | 0.0108 (4) | 0.0008 (5) |
| O12 | 0.0228 (5) | 0.0580 (7) | 0.0415 (6) | 0.0097 (5) | 0.0079 (4) | -0.0005 (5) |
| O13 | 0.0417 (6) | 0.0551 (7) | 0.0337 (6) | 0.0212 (5) | 0.0044 (5) | 0.0100 (5) |
| O14 | 0.0337 (6) | 0.0549 (7) | 0.0304 (6) | 0.0046 (5) | 0.0101 (4) | 0.0094 (5) |
| O15 | 0.0321 (6) | 0.0410 (6) | 0.0478 (7) | 0.0143 (5) | 0.0132 (5) | 0.0035 (5) |
| O16 | 0.0471 (7) | 0.0412 (6) | 0.0336 (6) | 0.0164 (5) | -0.0028 (5) | 0.0029 (5) |
| O17 | 0.0432 (6) | 0.0420 (6) | 0.0280 (5) | -0.0031 (5) | 0.0087 (5) | 0.0034 (4) |

Geometric parameters (Å, °)

| | | | |
|-------|-------------|---------|-------------|
| O1—C1 | 1.2438 (17) | C11—C12 | 1.4198 (19) |
| N1—C1 | 1.3688 (18) | C11—C16 | 1.4240 (19) |
| N1—N2 | 1.3733 (16) | C12—C13 | 1.385 (2) |
| N1—H1 | 0.94 (2) | C12—N11 | 1.4772 (17) |
| N2—C2 | 1.2990 (19) | C13—C14 | 1.3853 (19) |
| C1—C8 | 1.4659 (19) | C13—H13 | 0.9500 |
| C2—C3 | 1.439 (2) | C14—C15 | 1.387 (2) |
| C2—H2 | 0.9500 | C14—N12 | 1.4640 (18) |
| C3—C8 | 1.4102 (19) | C15—C16 | 1.378 (2) |
| C3—C4 | 1.413 (2) | C15—H15 | 0.9500 |
| C4—C5 | 1.381 (2) | C16—N13 | 1.4694 (17) |
| C4—H4 | 0.9500 | N11—O12 | 1.2238 (16) |
| C5—C6 | 1.400 (2) | N11—O13 | 1.2255 (17) |

| | | | |
|-------------|--------------|-----------------|--------------|
| C5—H5 | 0.9500 | N12—O14 | 1.2255 (16) |
| C6—C7 | 1.381 (2) | N12—O15 | 1.2356 (16) |
| C6—H6 | 0.9500 | N13—O16 | 1.2226 (16) |
| C7—C8 | 1.4019 (19) | N13—O17 | 1.2381 (17) |
| C7—H7 | 0.9500 | O11—H11 | 0.90 (3) |
| C11—O11 | 1.3214 (17) | | |
| C1—N1—N2 | 127.46 (12) | O11—C11—C12 | 120.86 (12) |
| C1—N1—H1 | 117.8 (11) | O11—C11—C16 | 124.09 (13) |
| N2—N1—H1 | 114.7 (11) | C12—C11—C16 | 115.01 (12) |
| C2—N2—N1 | 116.41 (12) | C13—C12—C11 | 122.63 (12) |
| O1—C1—N1 | 120.34 (12) | C13—C12—N11 | 115.59 (12) |
| O1—C1—C8 | 124.33 (12) | C11—C12—N11 | 121.74 (12) |
| N1—C1—C8 | 115.34 (12) | C12—C13—C14 | 118.79 (12) |
| N2—C2—C3 | 124.27 (13) | C12—C13—H13 | 120.6 |
| N2—C2—H2 | 117.9 | C14—C13—H13 | 120.6 |
| C3—C2—H2 | 117.9 | C13—C14—C15 | 121.91 (13) |
| C8—C3—C4 | 119.14 (13) | C13—C14—N12 | 118.66 (12) |
| C8—C3—C2 | 118.16 (12) | C15—C14—N12 | 119.41 (12) |
| C4—C3—C2 | 122.69 (13) | C16—C15—C14 | 118.24 (12) |
| C5—C4—C3 | 119.70 (14) | C16—C15—H15 | 120.9 |
| C5—C4—H4 | 120.1 | C14—C15—H15 | 120.9 |
| C3—C4—H4 | 120.1 | C15—C16—C11 | 123.37 (13) |
| C4—C5—C6 | 120.74 (13) | C15—C16—N13 | 116.56 (12) |
| C4—C5—H5 | 119.6 | C11—C16—N13 | 120.06 (12) |
| C6—C5—H5 | 119.6 | O12—N11—O13 | 123.34 (12) |
| C7—C6—C5 | 120.45 (14) | O12—N11—C12 | 119.68 (12) |
| C7—C6—H6 | 119.8 | O13—N11—C12 | 116.99 (11) |
| C5—C6—H6 | 119.8 | O14—N12—O15 | 124.04 (12) |
| C6—C7—C8 | 119.64 (13) | O14—N12—C14 | 117.92 (11) |
| C6—C7—H7 | 120.2 | O15—N12—C14 | 118.04 (12) |
| C8—C7—H7 | 120.2 | O16—N13—O17 | 123.57 (12) |
| C7—C8—C3 | 120.31 (12) | O16—N13—C16 | 118.27 (12) |
| C7—C8—C1 | 121.39 (12) | O17—N13—C16 | 118.15 (12) |
| C3—C8—C1 | 118.29 (12) | C11—O11—H11 | 106.6 (16) |
| C1—N1—N2—C2 | -0.1 (2) | C11—C12—C13—C14 | 0.0 (2) |
| N2—N1—C1—O1 | -177.43 (12) | N11—C12—C13—C14 | -177.71 (11) |
| N2—N1—C1—C8 | 2.34 (19) | C12—C13—C14—C15 | -0.7 (2) |
| N1—N2—C2—C3 | -1.3 (2) | C12—C13—C14—N12 | 177.76 (12) |
| N2—C2—C3—C8 | 0.3 (2) | C13—C14—C15—C16 | -0.2 (2) |
| N2—C2—C3—C4 | -179.38 (13) | N12—C14—C15—C16 | -178.67 (12) |
| C8—C3—C4—C5 | -0.9 (2) | C14—C15—C16—C11 | 1.9 (2) |
| C2—C3—C4—C5 | 178.79 (13) | C14—C15—C16—N13 | -178.00 (11) |
| C3—C4—C5—C6 | -0.1 (2) | O11—C11—C16—C15 | 175.42 (13) |
| C4—C5—C6—C7 | 1.0 (2) | C12—C11—C16—C15 | -2.40 (19) |
| C5—C6—C7—C8 | -0.8 (2) | O11—C11—C16—N13 | -4.7 (2) |
| C6—C7—C8—C3 | -0.22 (19) | C12—C11—C16—N13 | 177.46 (11) |

| | | | |
|-----------------|--------------|-----------------|--------------|
| C6—C7—C8—C1 | 179.16 (12) | C13—C12—N11—O12 | -170.29 (12) |
| C4—C3—C8—C7 | 1.09 (19) | C11—C12—N11—O12 | 11.95 (19) |
| C2—C3—C8—C7 | -178.64 (12) | C13—C12—N11—O13 | 9.31 (18) |
| C4—C3—C8—C1 | -178.31 (12) | C11—C12—N11—O13 | -168.45 (12) |
| C2—C3—C8—C1 | 1.96 (18) | C13—C14—N12—O14 | -7.04 (19) |
| O1—C1—C8—C7 | -2.7 (2) | C15—C14—N12—O14 | 171.43 (13) |
| N1—C1—C8—C7 | 177.49 (12) | C13—C14—N12—O15 | 173.74 (12) |
| O1—C1—C8—C3 | 176.65 (12) | C15—C14—N12—O15 | -7.79 (19) |
| N1—C1—C8—C3 | -3.12 (17) | C15—C16—N13—O16 | -7.40 (18) |
| O11—C11—C12—C13 | -176.48 (12) | C11—C16—N13—O16 | 172.73 (12) |
| C16—C11—C12—C13 | 1.42 (18) | C15—C16—N13—O17 | 171.79 (12) |
| O11—C11—C12—N11 | 1.12 (19) | C11—C16—N13—O17 | -8.08 (18) |
| C16—C11—C12—N11 | 179.02 (11) | | |

Hydrogen-bond geometry (Å, °)

| <i>D</i> —H... <i>A</i> | <i>D</i> —H | H... <i>A</i> | <i>D</i> ... <i>A</i> | <i>D</i> —H... <i>A</i> |
|-------------------------|-------------|---------------|-----------------------|-------------------------|
| N1—H1...O1 ⁱ | 0.94 (2) | 1.89 (2) | 2.8252 (16) | 175.2 (17) |
| O11—H11...O17 | 0.90 (3) | 1.79 (3) | 2.5819 (16) | 146 (2) |

Symmetry code: (i) $-x+1, -y+1, -z+1$.