refined using a riding model. The isotropic displacement parameters were set to 1.2 times (1.5 times for methyl groups) the equivalent displacement parameter of the atom they are attached to. The absolute structure were known for both compounds. For (I) the absolute structure parameter was consistent with this information [−0.0(3): Flack, 1983; Bernardinelli & Flack, 1985]. Compound (II) was measured with Mo radiation, and therefore the absolute structure could not be determined.

Atoms O1 and C5 of the oxazolidinone ring in (I) seemed to be disordered because of relatively high displacement parameters. Similar observations were made in (II) for this part of the structure, but with much lower values for the anisotropic displacement parameters. In consideration of the different temperatures for both data collections, we decided to interpret the high values for the anisotropic displacement parameters in (I) as thermal vibration instead of disorder.

All calculations were performed using the program *PUCKER* (Gould & Taylor, 1994; Cremer & Pople, 1975).

Data collection: *XSCANS* (Siemens, 1994) for (I); *DIF*4 (Stoe & Cie, 1988*a*) for (II). Cell refinement: *XSCANS* for (I); *DIF*4 for (II). Data reduction: *XSCANS* for (I); *REDU*4 (Stoe & Cie, 1988*b*) for (II). For both compounds, program(s) used to solve structures: *SHELXS*86 (Sheldrick, 1990); program(s) used to refine structures: *SHELXL*93 (Sheldrick, 1993); molecular graphics: *SHELXTL-Plus* (Sheldrick, 1994); software used to prepare material for publication: *SHELXL*93.

We thank the Deutsche Forschungsgemeinschaft and the Fonds der Chemischen Industrie for financial support.

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: JZ1097). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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N-[1-(2-Benzo[*b*]thienyl)ethyl]-*N*′-carbamoylurea and 1-[1-(2-Benzo[*b*]-thienyl)ethyl][1,3,5]triazine-2,4,6-trione Methanol Solvate

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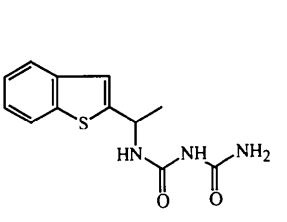
Abstract

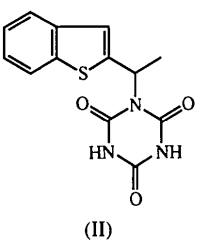
The title compounds, $C_{12}H_{13}N_3O_2S$ and $C_{13}H_{11}N_3O_3S.CH_4O$, were prepared by treating the precursor urea, [1-(2-benzo[*b*]thienyl)ethyl]urea, with *N*-chlorocarbonyl isocyanate. The products were isolated by preparative thin-layer chromatography. Analytical samples were obtained by crystallization from methanol and the crystal structures of both compounds were determined.

Comment

Leukotrienes have been linked to inflammatory disease and the pivotal enzyme responsible for initiating leukotriene biosynthesis is 5-lipoxygenase (Samuelsson, 1983). Zileuton, *N*-[1-(2-benzo[*b*]thienyl)ethyl]-*N*-hydroxyurea, is a selective inhibitor of 5-lipoxygenase currently undergoing clinical trials (Carter *et al.*, 1991; Israel *et al.*, 1993). During the course of the zileuton development program, many syntheses were investigated, some of which are documented (Hsiao & Kolasa, 1992). These synthetic efforts provided a large number of novel methodology-specific intermediates and by-products. As a consequence of our need to identify and monitor zileuton process-related entities, we synthesized and fully characterized the biuret title compound, *N*-[1-(2-benzo-[*b*]thienyl)ethyl]-*N*′-carbamoylurea, (I). This report describes the preparation, isolation and X-ray structure determination of compound (I) as well as the triazinetrione



(I)



(II)

by-product, 1-[1-(2-benzo[*b*]thienyl)ethyl][1,3,5]triazine-2,4,6-trione methanol solvate, (II).

Compound (I) exhibits disorder in the benzothiophene portion of the molecule (Fig. 1). This disorder is in the form of a 180° rotation of the benzothiophene moiety around the C1—C9 bond. As a result of the symmetry of the disordered group, only the S atom and the C atom in the 3 position are affected. The two disordered units exist in a 57:43 ratio with S1 and C2 being the major pair of atoms and S1*B* and C2*B* being the minor. This disorder is similar to that seen in (η^6-benzo[*b*]-thiophene)tricarbonylchromium(0) (Das *et al.*, 1992). In this case, however, the C and S atoms could be easily distinguished from one another. The benzothiophene group and C9 atom are coplanar, with an r.m.s. distance from the least-squares plane of 0.034 Å. Atoms C9, N1, C11, O1, N2, C12, O2 and N3 form the second plane of the molecule, with an r.m.s distance from the least-squares plane of 0.062 Å. The two planar portions of the molecule meet at an angle of 103.2°. The long-range ordering in the molecule consists of hydrogen-bonded sheets parallel to the *bc* plane (O1···H10 1.99, O1···H11 2.18 and O2···H12 1.98 Å).

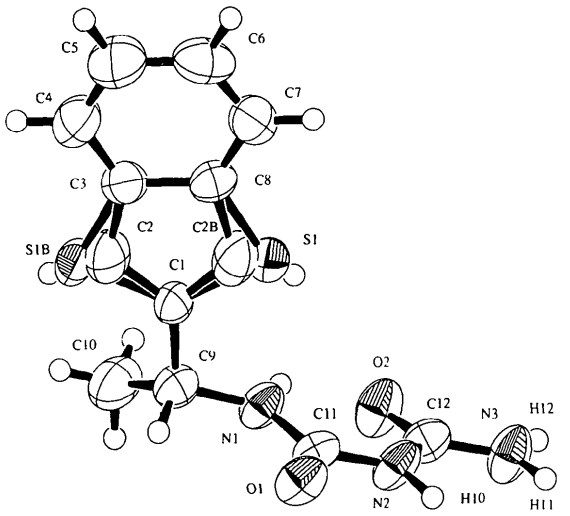


Fig. 1. An *ORTEP*II (Johnson, 1976) illustration of compound (I). Displacement ellipsoids are plotted at the 50% probability level and H atoms are drawn as circles of arbitrary radius.

Compound (II) shows none of the disorder seen in compound (I) (Fig. 2). The benzothiophene group and C4 atom are coplanar, with an r.m.s. distance from the least-squares plane of 0.031 Å. The triazinetrione moiety and C4 atom are also coplanar, with an r.m.s. distance of 0.044 Å. The two planes of the molecule meet at an angle of 120.0°. The long-range ordering in compound (II) consists of hydrogen-bonded dimers (O2···H13 1.83 Å) held together in sheets parallel to the *bc* plane by hydrogen-bonded contacts to the methanol molecule (O3···H15 1.71 and O4···H14 1.66 Å).

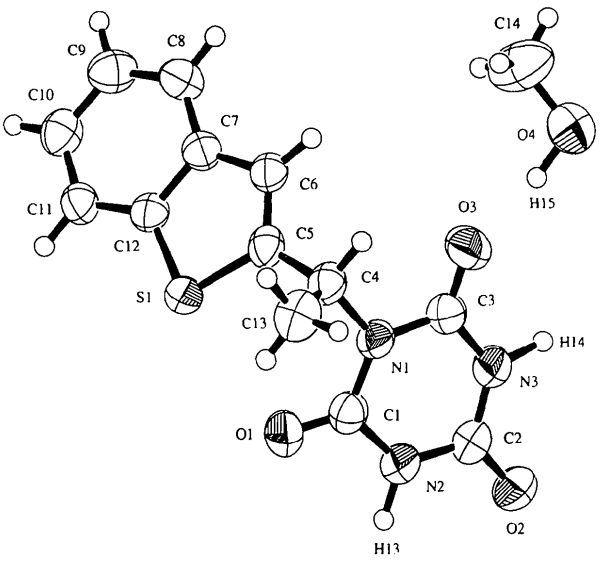


Fig. 2. An *ORTEP*II (Johnson, 1976) illustration of compound (II). Displacement ellipsoids are plotted at the 50% probability level and H atoms are drawn as circles of arbitrary radius.

Experimental

The title compounds were prepared in the following manner: [1-(2-benzo[*b*]thienyl)ethyl]urea (0.50 g, 2.3 mmol theoretical) was suspended in dry tetrahydrofuran (10 ml) under N_2 and treated with *N*-chlorocarbonyl isocyanate (0.27 g; 2.6 mmol theoretical). The starting material dissolved as the solution was warmed from 294 to 301 K. After 30 min, concentrated HCl (3 ml) was added and the reaction mixture refluxed for a further 30 min, whereupon it was cooled to room temperature and treated with concentrated NH_4OH (3.5 ml). The reaction was stirred overnight, then condensed under reduced pressure. A portion of the resulting off-white semi-solid was chromatographed on silica TLC plates using EtOAc as eluant. The band at R_f = 0.40 was removed, extracted with MeOH and recrystallized from MeOH yielding compound (I). A second band at R_f = 0.64 was removed, extracted with MeOH and recrystallized from MeOH affording compound (II).

Compound (I)

Crystal data

$C_{12}H_{13}N_3O_2S$
M_r = 263.31
Monoclinic
$P2_1/c$
a = 11.916 (3) Å
b = 6.132 (1) Å
c = 17.832 (3) Å
β = 101.88 (1)°
V = 1275.1 (4) Å^3
Z = 4
D_x = 1.371 Mg m^{-3}
Cu $K\alpha$ radiation
λ = 1.54178 Å
Cell parameters from 24 reflections
θ = 44.90–52.98°
μ = 2.21 mm^{-1}
T = 298 K
Blade
0.4 × 0.2 × 0.1 mm
Clear

Data collection

Rigaku AFC-5*R* diffractometer
ω scans
1456 observed reflections [$I > 3\sigma(I)$]
R_{int} = 0.037

Absorption correction: empirical *via* ψ scan (North, Phillips & Mathews, 1968)
T_{min} = 0.760, T_{max} = 1.000
2205 measured reflections
2096 independent reflections

θ_{max} = 60.1°
$h = 0 \rightarrow 13$
$k = 0 \rightarrow 6$
$l = -20 \rightarrow 20$
3 standard reflections
monitored every 150 reflections
intensity decay: 0.34%

Refinement

Refinement on F
R = 0.043
wR = 0.042
S = 2.91
1456 reflections
181 parameters
H-atom parameters not refined
Weighting scheme based on measured e.s.d.'s

$(\Delta/\sigma)_{max}$ = 0.05
$\Delta\rho_{max}$ = 0.19 e Å^{-3}
$\Delta\rho_{min}$ = −0.17 e Å^{-3}
Extinction correction: none
Atomic scattering factors from *International Tables for X-ray Crystallography* (1974, Vol. IV)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters (Å²) for (I)*

$B_{eq} = (8\pi^2/3)\sum_i\sum_j U_{ij} a_i^* a_j^* \mathbf{a}_i.\mathbf{a}_j$.

	x	y	z	B_{eq}
S1†	0.3811 (3)	0.1201 (6)	0.3512 (3)	4.4 (1)
S1*B*‡	0.4840 (5)	−0.3178 (8)	0.4111 (4)	4.7 (2)
O1	0.1068 (2)	−0.0573 (4)	0.2771 (1)	4.6 (1)
O2	0.0711 (2)	0.2696 (4)	0.4728 (1)	5.0 (1)
N1	0.1788 (2)	−0.0288 (5)	0.4048 (1)	3.9 (1)
N2	0.0373 (2)	0.2054 (5)	0.3431 (1)	4.2 (1)
N3	−0.0424 (2)	0.4988 (5)	0.3910 (1)	4.8 (1)
C1	0.3729 (3)	−0.1341 (6)	0.3916 (2)	3.6 (1)
C2†	0.474 (1)	−0.239 (2)	0.399 (1)	5.3 (6)
C2*B*‡	0.402 (2)	0.046 (3)	0.360 (1)	5.9 (9)
C3	0.5666 (3)	−0.1322 (6)	0.3739 (2)	4.4 (2)
C4	0.6790 (3)	−0.1831 (7)	0.3693 (2)	6.3 (2)
C5	0.7409 (3)	−0.0375 (8)	0.3372 (3)	6.9 (2)
C6	0.6949 (4)	0.1589 (8)	0.3093 (2)	5.9 (2)
C7	0.5847 (3)	0.2146 (6)	0.3133 (2)	5.1 (2)
C8	0.5202 (3)	0.0684 (6)	0.3458 (2)	4.1 (2)
C9	0.2589 (3)	−0.2091 (6)	0.4080 (2)	4.0 (2)
C10	0.2739 (3)	−0.3234 (7)	0.4836 (2)	6.2 (2)
C11	0.1094 (2)	0.0305 (6)	0.3399 (2)	3.7 (1)
C12	0.0240 (3)	0.3241 (6)	0.4069 (2)	4.0 (2)

† Site occupancy = 0.57. ‡ Site occupancy = 0.43.

Compound (II)

Crystal data

$C_{13}H_{11}N_3O_3S.CH_4O$
M_r = 321.35
Monoclinic
$P2_1/c$
a = 17.124 (2) Å
b = 5.7739 (9) Å
c = 15.34 (1) Å
β = 91.20 (2)°
V = 1516 (1) Å^3
Z = 4
D_x = 1.408 Mg m^{-3}

Cu $K\alpha$ radiation
λ = 1.54178 Å
Cell parameters from 23 reflections
θ = 52.46–58.64°
μ = 2.05 mm^{-1}
T = 298 K
Plate
0.3 × 0.3 × 0.1 mm
Clear

Data collection

Rigaku AFC-5*R* diffractometer
ω scans

1797 observed reflections $[I > 3\sigma(I)]$
R_{int} = 0.046

Absorption correction: empirical *via* ψ scan (North, Phillips & Mathews, 1968)
T_{min} = 0.735, T_{max} = 1.000
2634 measured reflections
2527 independent reflections

θ_{max} = 74.7°
$h = -19 \rightarrow 19$
$k = 0 \rightarrow 6$
$l = 0 \rightarrow 17$
3 standard reflections
monitored every 150 reflections
intensity decay: 5.19%

Refinement

Refinement on F
R = 0.050
wR = 0.064
S = 3.00
1797 reflections
199 parameters
H-atom parameters not refined
Weighting scheme based on measured e.s.d.'s

$(\Delta/\sigma)_{max}$ = 0.01
$\Delta\rho_{max}$ = 0.22 e Å^{-3}
$\Delta\rho_{min}$ = −0.21 e Å^{-3}
Extinction correction: none
Atomic scattering factors from *International Tables for X-ray Crystallography* (1974, Vol. IV)

Table 2. *Fractional atomic coordinates and equivalent isotropic displacement parameters (Å²) for (II)*

$B_{eq} = (8\pi^2/3)\sum_i\sum_j U_{ij} a_i^* a_j^* \mathbf{a}_i.\mathbf{a}_j$.

	x	y	z	B_{eq}
S1	0.65670 (4)	0.1720 (1)	0.34944 (5)	4.31 (3)
O1	0.7867 (1)	0.1385 (4)	0.4827 (1)	5.2 (1)
O2	1.0456 (1)	0.2149 (4)	0.4356 (1)	5.6 (1)
O3	0.8776 (1)	0.7482 (4)	0.3266 (1)	5.9 (1)
O4	0.9212 (1)	1.1215 (4)	0.2288 (1)	6.2 (1)
N1	0.8287 (1)	0.4607 (4)	0.4111 (1)	4.1 (1)
N2	0.9166 (1)	0.1819 (4)	0.4641 (1)	4.4 (1)
N3	0.9616 (1)	0.4831 (4)	0.3809 (1)	4.3 (1)
C1	0.8395 (2)	0.2529 (5)	0.4542 (2)	4.3 (1)
C2	0.9788 (2)	0.2886 (5)	0.4268 (2)	4.3 (1)
C3	0.8885 (2)	0.5753 (5)	0.3695 (2)	4.3 (1)
C4	0.7491 (2)	0.5632 (5)	0.4027 (2)	4.4 (1)
C5	0.6992 (1)	0.4417 (5)	0.3337 (2)	4.0 (1)
C6	0.6811 (2)	0.5358 (5)	0.2552 (2)	3.9 (1)
C7	0.6289 (2)	0.3902 (5)	0.2036 (2)	4.0 (1)
C8	0.5946 (2)	0.4296 (5)	0.1214 (2)	4.9 (1)
C9	0.5439 (2)	0.2703 (6)	0.0862 (2)	5.3 (2)
C10	0.5261 (2)	0.0674 (5)	0.1309 (2)	4.8 (1)
C11	0.5592 (2)	0.0241 (5)	0.2115 (2)	4.3 (1)
C12	0.6103 (1)	0.1851 (4)	0.2477 (2)	3.9 (1)
C13	0.7102 (2)	0.5922 (6)	0.4890 (2)	5.7 (2)
C14	0.8501 (2)	1.1727 (8)	0.1869 (3)	8.4 (2)

For both compounds, data collection: *MSC/AFC Diffractometer Control Software* (Molecular Structure Corporation, 1988); cell refinement: *MSC/AFC Diffractometer Control Software*; data reduction: *MSC/AFC Diffractometer Control Software*; program(s) used to solve structures: *SHELXS*86 (Sheldrick, 1990); program(s) used to refine structures: *TEXSAN* (Molecular Structure Corporation, 1993); software used to prepare material for publication: *TEXSAN*.

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: SZ1014). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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6-Acetamido-4-methoxy-2-methylthiopyrimidine

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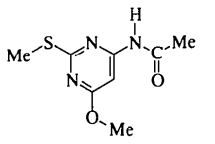
Abstract

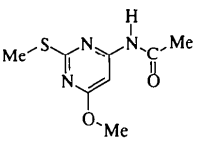
Molecules of the title compound, 4-methoxy-2-methylthio-6-pyrimidinylacetamide, $C_8H_{11}N_3O_2S$, lie on crystallographic mirror planes and are linked by N—H···O hydrogen bonds to form zigzag ribbons running parallel to the *a* axis, with an N···O distance of 3.018 (2) Å.

Comment

Derivatives of 6-aminopyrimidines are of interest because of both their biological activity (Cobo, 1995) and their use as intermediates in the synthesis of other nucleoside derivatives (Low *et al.*, 1996). Our analysis of the title compound, (1), is part of a series of such studies.



(1*a*)



(1*b*)

Apart from the methyl H atoms, all the atoms of the molecule (Fig. 1) lie on a crystallographic mirror plane. Molecular dimensions (Table 2) are consistent with equal contributions from resonance forms (1*a*) and (1*b*), and are in agreement with dimensions reported for the parent compound 6-amino-4-methoxy-2-methylthiopyrimidine (Low *et al.*, 1996).

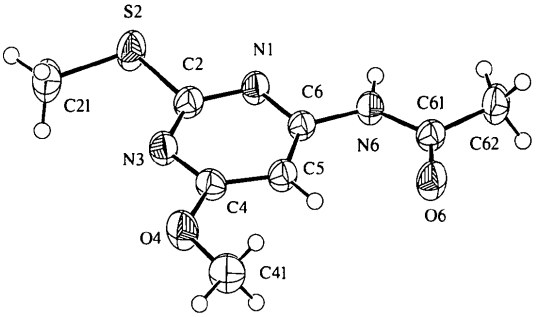


Fig. 1. A view of (1) with the atomic numbering scheme. Displacement ellipsoids are drawn at the 30% probability level. Only one orientation of the disordered H atoms on C62 is shown.

Molecules of (1) are linked into zigzag chains by N—H···O hydrogen bonds (Fig. 2 and Table 2) extending along the **a** direction. There is also a short C—H···O intramolecular contact between the H atom on the C5 atom and the adjacent carbonyl O6 atom. These links serve to keep the structure fairly rigid and explain why the data collection was able to obtain measurable reflections up to a θ value of 30° with Mo radiation.

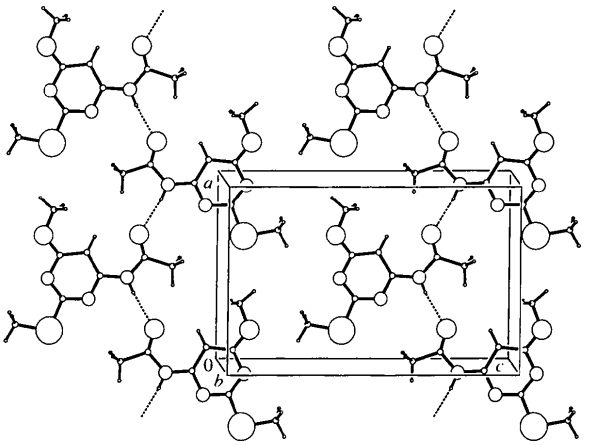


Fig. 2. A view of part of the the crystal structure of (1) showing the hydrogen-bonded chains.

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